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**FIELD ARTILLERY MISSION WEAPON AND  
ORGANIZATION FOR COUNTERGUERRILLA WARFARE (U)**

**An abstract for a thesis presented to the Faculty of  
the U. S. Army Command and General Staff College in  
partial fulfillment of the requirements of the  
degree**

**MASTER OF MILITARY ART AND SCIENCE**

**by  
K. S. HEITZKE, Major, USA**

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**Fort Leavenworth, Kansas  
1965**

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U. S. ARMY COMMAND AND GENERAL STAFF COLLEGE

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Counter guerrilla Warfare (U)

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The opinions and conclusions expressed herein are those of the individual student author and do not necessarily represent the views of either the United States Army Command and General Staff College or any other governmental agency.

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Since World War II many nations, including the United States, have become deeply involved in counter guerrilla warfare. Guerrilla warfare, and consequently counter guerrilla warfare, is expected to be with mankind as long as the breeding grounds for Communist infiltration and Communist inspired insurgency exist in the underdeveloped and unstable countries of the world. During the past decade many books and articles have been written on counter guerrilla warfare but little has been written on the use of field artillery in such operations.

The purpose of this thesis is to determine the field artillery mission weapon and organization which can best support a counter guerrilla operation. To limit the scope of the thesis, the following limitations and assumptions are made:

1. The area of operations is assumed to be in an underdeveloped country located in the tropics.
2. The environment of operations is that of a sublimited war.
3. The military force supported by the field artillery is limited to an infantry brigade in size.

The thesis is divided into three general phases. The first phase sets the scene, so to speak, by describing the environment of the guerrilla, discussing guerrilla tactics and techniques, describing U. S. Army doctrine for counter guerrilla warfare, and describing the type force assumed to be conducting the counter guerrilla operation.

The second phase determines the desirable characteristics of the field artillery weapon and field artillery personnel requirements deemed necessary for effective counter guerrilla warfare. The desirable

characteristics and personnel requirements are based on the experiences of field artillery units in jungle warfare and counter guerrilla operations in Vietnam. For clarity, the determination of the desirable characteristics of the weapon is divided into two categories: fire-power and mobility.

The third phase is a comparison of four U. S. field artillery weapons (the 75-mm pack howitzer and the 105-mm howitzers, M101A1, M102, and M104) with the desirable characteristics and a comparison of the personnel requirements with the present field artillery battalion organization.

Based on these comparisons, the following conclusions are reached:

1. The self-propelled M104 should be made the direct support field artillery weapon in counter guerrilla warfare because of its superior counter guerrilla capabilities of mobility, maneuverability, obstacle crossing ability, battlefield survivability, and reduced crew requirements.
2. The eighteen excess personnel in the howitzer sections, which result from using the M104, should be added to the observer sections; and the necessary changes in grade and military occupational speciality should be made.
3. Twenty of the thirty survey and radar personnel in the battalion should be cross-trained in fire direction procedures.
4. An infantry squad should be attached to each platoon of howitzers for security of the position area when the field artillery is employed by platoons.

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## INTRODUCTION

A few years ago President Kennedy, when referring to guerrilla warfare, stated, "Another military dimension has necessarily been added to the American profession of arms."<sup>1</sup> But guerrilla warfare is not a new type warfare in the sense of time, for guerrilla warfare was employed hundreds of years ago by Hannibal. Considering only American wars, the hit-and-run tactics of Rogers and Marion during the Revolutionary War are well known to every schoolboy. Nor is guerrilla warfare another type of warfare due to the principles of war involved. The nine principles of war,<sup>2</sup> as taught in the U. S. Army service schools, apply as much to guerrilla warfare as they do to conventional warfare. Guerrilla warfare is new because the military student has recently been forced to recognize its existence and the military services have been forced to develop the tactics and techniques peculiar to guerrilla warfare as well as to develop the tactics and techniques of counter guerrilla warfare. As Maj. Gen. W. R. Peers, Assistant Deputy Chief of Staff for Special Operations, Department of the Army, remarked:

Any "newness" lies in the fact that as the major powers have reached a state of nuclear stand-off, our military establishment--in particular the Army--has had to rapidly focus its attention on

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<sup>1</sup>U. S., Continental Army Command, World Wide Combat Arms Conference II (U), Vol I (3 vols.; Washington, D. C.: U. S. Continental Army Command, 1962), p. 126.

<sup>2</sup>The nine principles of war are: Objective, Surprise, Unity of Command, Maneuver, Mass, Economy of Force, Simplicity, Security, and Offensive.

coping with this lower level of warfare on a world-wide and intensified basis.<sup>3</sup>

Until recently, most military students were concerned mainly with what is now called "conventional warfare"; that is, a war consisting of large forces fighting according to certain generally accepted rules of land warfare. The military professional gave little thought to guerrilla warfare since he was not threatened with this form of warfare. In the past when guerrilla warfare was considered in service school problems, the guerrilla force was usually placed behind our lines and the countering tactics were those of a conventional force albeit on a smaller scale. But present day guerrilla warfare is of a different nature, as is discussed later in Chapter I. Consequently, the tactics and techniques of guerrilla warfare and counter guerrilla warfare are something new to be studied and learned.

Since World War II, there have been numerous guerrilla wars-- some successful and some unsuccessful. There have been guerrilla operations in Indochina, Greece, the Philippine Islands, Korea, Algeria, Cuba, and Vietnam. Every indication is that guerrilla type wars will be with mankind as long as the breeding grounds for Communist infiltration and Communist inspired insurgency exist in the underdeveloped and unstable countries of the world. Almost everyone is familiar with Nikita Khrushchev's often quoted remark concerning Russia's support of "wars of liberation and popular uprisings." In November 1964, the present Communist Party Leader, Leonid Brezhnev, restated the policy when he said the Soviet Union is pledged to support

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<sup>3</sup>W. R. Peers, "Meeting the Challenge of Subversion," Army, November 1964, p. 95.

"the national liberation struggle of the people of Asia, Africa and Latin America."<sup>4</sup> Gen. Harold K. Johnson, Chief of Staff of the U. S. Army, at the annual meeting of the Association of the United States Army in 1964, said:

So long as our deterrent posture remains strong and versatile, the efforts of the Communists and their henchmen to gain their goals will be carried out by guerrilla warfare, revolutionary operations, insurgency, terrorism, and the entire catalogue of violence now described by the Communists as Wars of National Liberation.<sup>5</sup>

President Kennedy, during his speech to the graduating class at the United States Military Academy in June 1962, stated:

It [guerrilla warfare] is a form of warfare uniquely adapted to what has been strangely called "wars of liberation," to undermine the efforts of new and poor countries to maintain the freedom that they have finally achieved. It preys on economic and ethnic conflict.

It requires in those situations where we must counter it--and these are the kinds of challenges that will be before us in the next decade--if freedom is to be saved, a whole new kind of strategy, a wholly different kind of force, and therefore a new and wholly different kind of military training.<sup>6</sup>

The challenge is real and the U. S. military establishment is meeting the challenge through specialized training and the development of the doctrine and equipment peculiar to guerrilla and counter guerrilla warfare. For example, U. S. Army Special Warfare School was established at Fort Bragg, North Carolina. The U. S. Army guerrilla and counter guerrilla doctrine, tactics, and techniques have been refined and are constantly being evaluated based on the Army's experiences in Vietnam

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<sup>4</sup>"Communists: The Era of Many Romes," Time, 13 November 1964, p. 44.

<sup>5</sup>"C of S Johnson Defines Army's Task to AUSA: Landpower Missions Unlimited," The Journal of the Armed Forces, 21 November 1964, p. 16.

<sup>6</sup>New York Times, 7 June 1962, p. 26.

and elsewhere. During the past few years, thousands of books, articles, and manuals have been written on guerrilla and counter guerrilla warfare. Recently the U. S. Army divisions have been reorganized so they could be tailored to better accomplish any of the various tasks which may be assigned, including counter guerrilla operations. General Johnson, during his speech to the Association of the United States Army in November 1964, stated:

We have . . . clear requirements for light, mobile, highly versatile forces which permit us the strong reflexes essential to prompt action in those situations where aggression is a combination of political, social and military factors and the conflict itself may never be formally identified as a war.

The U. S. Army has the doctrine and organization which should be suitable for effectively countering the guerrilla. One can only presume that counter guerrilla warfare can be waged successfully because the Army has not engaged in any such operation since the divisions were reorganized under the ROAD (Reorganization Objective Army Divisions) Concept. This introduces the purpose of this paper.

The purpose of this paper is to determine, based on the Army's present doctrine and organization, the field artillery equipment and organization which can best support a counter guerrilla operation. Only the major items of equipment, that is, the weapons and vehicles, are considered.

Despite the numerous books and articles written on counter guerrilla warfare since the end of World War II, little has been written concerning the use of field artillery in such operations. Most articles merely acknowledge the presence of the field artillery by stating the operation was, or could have been, supported by field artillery. But,

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<sup>7</sup>The Journal of the Armed Forces, loc. cit.



as Maj. John C. Love wrote in the Marine Corps Gazette, "If, in counter guerrilla action, the rifleman is denied artillery support, he is placed on an almost equal level with the guerrilla himself."<sup>8</sup> Field artillery does have a specific mission in counter guerrilla operations. Although the mission is the same as the mission for conventional warfare (that is, to support the maneuver elements by fire), in counter guerrilla warfare, however, the manner in which the mission is accomplished must, due to the nature of the operation, differ from the manner in which the mission is accomplished in conventional warfare. Because of this difference there may be a requirement for a change in the field artillery equipment and organization from that used in conventional warfare.

This analysis is limited to counter guerrilla operations conducted in an underdeveloped country in the tropics during a sublimated war.<sup>9</sup> The military unit supported is assumed to be of brigade size, but tailored for the operation. The reasons for placing such limits on the analysis are contained in Chapters I and II. Chapters I and II set the scene, so to speak, by describing the typical environment of the guerrilla, discussing guerrilla tactics and techniques, describing the tactics and techniques contained in U. S. Army doctrine for counter guerrilla warfare and, lastly, describing the type force assumed to be conducting the counter guerrilla operations. The next two chapters present the field artillery requirements to shoot and move, in that order, to determine the desirable characteristics of the major items

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<sup>8</sup>John C. Love, "Rocket Artillery: A New Challenge," Marine Corps Gazette, July 1964, pp. 28-29.

<sup>9</sup>Definitions peculiar to special warfare are contained in Appendix I.

of field artillery equipment and the need for additional personnel for successful counter guerrilla operations. In Chapters V and VI certain United States weapons are compared with the desirable characteristics determined in Chapter IV to ascertain which weapons would be the most effective for counter guerrilla operations. Chapter VII presents the personnel changes, to the normal field artillery battalion organization, deemed necessary to counter the guerrilla. Chapter VIII summarizes the discussion and gives the conclusions and recommendations.

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## CHAPTER I

### AREA OF OPERATIONS AND GUERRILLA TACTICS

To determine the field artillery equipment and organization which can best support a counter guerrilla operation, it is necessary to describe the terrain and climate of the expected area of operations, the tactics used by the guerrilla, the tactics of the counter guerrilla force and the organization of the force being supported by the field artillery. This chapter is concerned with the first two: the area of operations and the tactics of the guerrilla. Chapter II describes U. S. counter guerrilla tactics and the organization of the force being supported.

#### Area of Operations

As indicated in the Introduction, the underdeveloped countries and the newly emerging countries of the world are ripe for Communist inspired insurgency. These are the countries in which most of the recent unrest in the world has been displayed. Almost daily we read of strikes, student uprisings, rebellions, coup d'états, or riots in these countries. A look at a map will show that most of the underdeveloped and newly emerging nations are located between the Tropic of Cancer and the Tropic of Capricorn; that is, in what is known as the tropics. Included in this area are the countries of Southeast Asia; Africa, south of the Sahara Desert; Central America; and almost all of

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South America. The area, which includes about one-third of the land surface of the world, is the area in which the United States can expect to conduct counter guerrilla operations.

Each of the countries in the tropics differ, to some extent, as far as terrain, climate, and vegetation are concerned. Rather than describe the terrain and climate of each of these countries in detail, only the general characteristics of the area<sup>1</sup> will be presented. This will suffice for the analysis which follows.

The climate in this area ranges from a dry climate to a tropical forest climate with rainfall throughout the year. Most of the area has a mean annual precipitation of about fifty inches or greater. Vegetation varies from desert vegetation to tropical rain forest. Elevations extend from sea level to 10,000 feet above sea level. Excluding India, the area has an extremely poor highway and railway system. The economies are generally agrarian, and there is intense poverty and an absence of an established middle class.<sup>2</sup> Considering only the newly independent countries and the underdeveloped countries, it might be said the area falls into broad categories; (1) tropical areas noted for jungles, swamps, marshes, and rice paddies, and (2) mountainous areas noted for rugged and difficult terrain. In both areas there is a lack of roads, railroads, and bridges. Generally, the entire area is ideal terrain from the guerrilla's viewpoint, as will be discussed later in this chapter, but is extremely poor from the viewpoint of the counter guerrilla force.

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<sup>1</sup>For the remainder of Chapter I, the word "area" will refer to the tropics.

<sup>2</sup>J. Paul Goode, Goode's School Atlas, rev. Edward B. Espenshade, Jr. (New York: Rand McNally and Company, 1950), pp. 7, 9, 10-11, 12-13, 16-17, 22-23.

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A handbook prepared by the Special Warfare Division of the Office of the Deputy Chief of Staff for Operations, Department of the Army, summarizes the salient characteristics of the area of operations for past guerrilla wars as follows:

1. Underdeveloped resources and industry with a marginal agrarian society.
2. Considerable areas that are sparsely populated due to the existence of desert, mountains, forest, and jungles.
3. Inadequate modern transportation and communication facilities.
4. Marginal or low standard of living for the majority of the people.
5. Periodic crop failure with accompanying famine.
6. High illiteracy rate and lack of educational institutions and hospital and sanitation facilities.
7. Majority of the wealth, industry, and land concentrated in the hands of a small privileged class.
8. Unstable government and immature political development.
9. Widespread graft and corruption in the government, military, police organization, and political parties.
10. Professionally substandard military and police establishments.<sup>3</sup>

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<sup>3</sup>U. S., Department of the Army, Counter Insurgency Operations (U) (Washington, D. C.: Department of the Army, 1962), p. 5.

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## Guerrilla Tactics

"The general features of orthodox hostilities, that is, the war of position and the war of movement, differ fundamentally from guerrilla warfare. There are other readily apparent differences such as those in organization, armament, equipment, supply, tactics, command; in the conception of the terms 'front' and 'rear'; in the matter of military responsibilities."<sup>4</sup> Thus, in general terms, Mao Tze-tung noted the areas in which guerrilla warfare differs from conventional warfare. This section discusses the tactics employed by guerrilla forces to furnish a basis for determining the desirable characteristics of the field artillery weapon to be employed in counter guerrilla warfare. No attempt is made to compare the guerrilla tactics with conventional tactics. Such items as organization and equipment are mentioned only briefly.

Mao Tze-tung stated the mission of the guerrilla in very few well chosen words when he wrote:

As to the matter of military responsibilities; those of the guerrillas are to exterminate small forces of the enemy; to harass and weaken large forces; to attack enemy lines of communication; to establish bases capable of supporting independent operations in the enemy's rear; to force the enemy to dispose his strength; and to coordinate all these activities with those of regular armies on distant battle fronts.<sup>5</sup>

The basic doctrine of guerrilla warfare is contained in the writings of Mao Tze-tung and Che Guevara although these writings have added little to the theory or doctrine of guerrilla warfare. The tactics of guerrilla warfare have changed little, if any, during the

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<sup>4</sup>Mao Tze-tung, On Guerrilla Warfare, trans. S. B. Griffith (New York: Frederick A. Praeger, 1961), p. 42.

<sup>5</sup>Ibid., p. 53.

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many years guerrilla have been fighting wars. However, Mao Tze-tung was one of the first to make a detailed analysis of the tactics employed by the successful guerrilla and put the tactics into writing. Che Guevara stated the guerrilla tactics in a few words: "Hit and run, wait, lie in ambush, again hit and run, and thus repeatedly [sic], without giving any rest to the enemy."<sup>6</sup> Mao Tze-tung states:

In guerrilla warfare select the tactics of seeming to come from the east and attacking from the west; avoid the solid; attack the hollow; attack; withdraw; deliver a lightning blow, seek a lightning decision. When guerrillas engage a stronger enemy then withdraw when he advances; harass him when he stops; strike him when he is weary; pursue him when he withdraws.<sup>7</sup>

Therefore, guerrilla warfare is characterized by rapid movement, offensive action by small units, and a rapid disengagement and withdrawal. Major offensive engagements seldom take place, and guerrillas rarely fight a defensive action unless forced to do so.

The basis of successful guerrilla warfare is offensive action, or, as Field Manual 31-15 states, "The guerrilla byword is attack."<sup>8</sup> These attacks are usually carried out during the hours of darkness or low visibility to obtain surprise. Since the guerrilla is usually inferior in combat power to the enemy, the guerrilla must rely heavily on surprise. His attacks are of an intensive nature but of short duration. After accomplishing his mission, whether it be to destroy personnel, equipment, or an installation, he quickly disengages and withdraws before the enemy can bring up a countering force or before the element of surprise has ended. Field Manual 31-15 states the

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<sup>6</sup>Che Guevara, Guerrilla Warfare, trans. J. P. Morray (New York: Monthly Review Press, 1961), pp. 19-20.

<sup>7</sup>Mao Tze-tung, op. cit., p. 46.

<sup>8</sup>Special Warfare Operations, op. cit., p. 115.

ambush is the most common guerrilla form of offensive action. The guerrilla force sets up the ambush, normally directed against foot, rail or motor movement, based on thorough intelligence and detailed planning. The ambush is "executed with surprise, shrewdness, and violent determination." Silence and concealment are emphasized by the ambush force; and frequently secondary ambushes, some distance from the location of the main ambush, are used to destroy enemy reinforcements.<sup>9</sup> A U. S. Army Command and General Staff College report states a tactic frequently used by the guerrilla is to launch an ambush, inflict maximum destruction on the target and withdraw to previously selected hiding places before the enemy can recover from the attack and interdict the guerrilla's routes of escape.<sup>10</sup>

Generally, then, the guerrilla's offensive actions take the form of ambushes or attacks against small isolated outposts. The guerrilla relies heavily on the element of surprise, on his knowledge of his enemy and the terrain, on his operating in difficult terrain to offset the mobility and firepower advantage of his enemy, and on his ability to rapidly traverse the difficult terrain.

The defensive tactics of the guerrilla are simple to describe since they are offensive in nature. Mao Tze-tung wrote:

There can be . . . no assumption of a negative or passive defense.

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<sup>9</sup>Ibid., pp. 30-31.

<sup>10</sup>U. S. Army Command and General Staff College, A Detailed Concept for Employment of US Army Combat Units in Military Operations Against Irregular Forces (U) (Fort Leavenworth: U. S. Army Command and General Staff College, 1962), p. D-1.

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When a guerrilla unit, due to either a poor estimate on the part of its leader or pressure from the enemy, is forced into a passive position its first duty is to extricate itself.<sup>11</sup>

Hence, defensive tactics have no place in guerrilla warfare; and, as was stated earlier, guerrillas seldom go on the defensive. When forced to go on the defensive, they will not fight a position type defense but will either attack to extricate themselves or else attempt to exfiltrate.

All in all, the guerrilla is a very elusive individual who wants to fight only when the odds are in his favor. Whenever possible, he selects the terrain, which normally is the most difficult in the area, for the site of the engagement. Consequently, he is able to neutralize the enemy's superior mobility and firepower. He will seldom fight a defensive battle, but, if he is forced to do so, will attempt to escape rather than fight a defensive battle of the position nature of conventional warfare.

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<sup>11</sup>Mao Tze-tung, op. cit., p. 97 and p. 101.

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## CHAPTER II

### U. S. COUNTERGUERRILLA TACTICS AND A TYPE U. S. COUNTERGUERRILLA FORCE

#### U. S. Counter guerrilla Tactics

The United States counter guerrilla tactics, strangely enough, might be summed up in the infantry slogan of "find them, fix them, fight them, and finish them." Field Manual 31-15, for simplicity, classifies counter guerrilla operations as:

1. Harassing operations.
2. Offensive operations.
3. Denial operations.<sup>1</sup>

Harassing operations are designed primarily to locate the enemy and keep him on the move or on the defensive. Offensive operations are designed to eliminate the guerrilla. Denial operations are, as the name implies, designed to keep the enemy from a certain locale or to deny him access to a neighboring country.

Offensive operations, the major concern of this paper, can be further classified as a:

1. Rabbit hunt.
2. Fire flush.

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<sup>1</sup>U. S., Army Combat Developments Command Combined Arms Agency, Final Draft Manuscript; Special Warfare Operations, Field Manual 31-15 (Fort Leavenworth: U. S. Army Combat Developments Command, 1964), p. 68.

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3. Encirclement.

4. Pursuit.

The rabbit hunt is most effective for operations against guerrillas located in relatively small areas. A hunting force starts at one end of an area and systematically moves through the area and either destroys the guerrilla or forces him deeper into the area. Since the area is relatively small, artillery is of little use in this type operation.

The fire flush, which is a variation of the rabbit hunt, can make effective use of field artillery. Figure 1 depicts this operation.

Blocking or ambush forces are located around an area of approximately 1000 meters square (1000 meters on a side). The area is subjected to intense fire from indirect fire weapons or tactical air. The blocking or ambush force prevents the guerrilla from leaving the area, and the reserves are available to prevent any large scale breakout.

Of the three offensive actions the encirclement, according to Field Manual 31-16, offers the greatest possibility for fixing the enemy in position and destroying him. It is also one of the most difficult operations to conduct and requires a relatively high preponderance of friendly troops. The planning and execution of an encirclement are designed for a sudden and complete encirclement of the enemy. Normally, to achieve surprise, the line of encirclement is occupied during the hours of darkness; and, upon arriving on the line of encirclement, the units occupy defensive positions. Following the initial encirclement, the capture or destruction of the guerrilla force can be accomplished by any of the following means:

1. Enticement to surrender.

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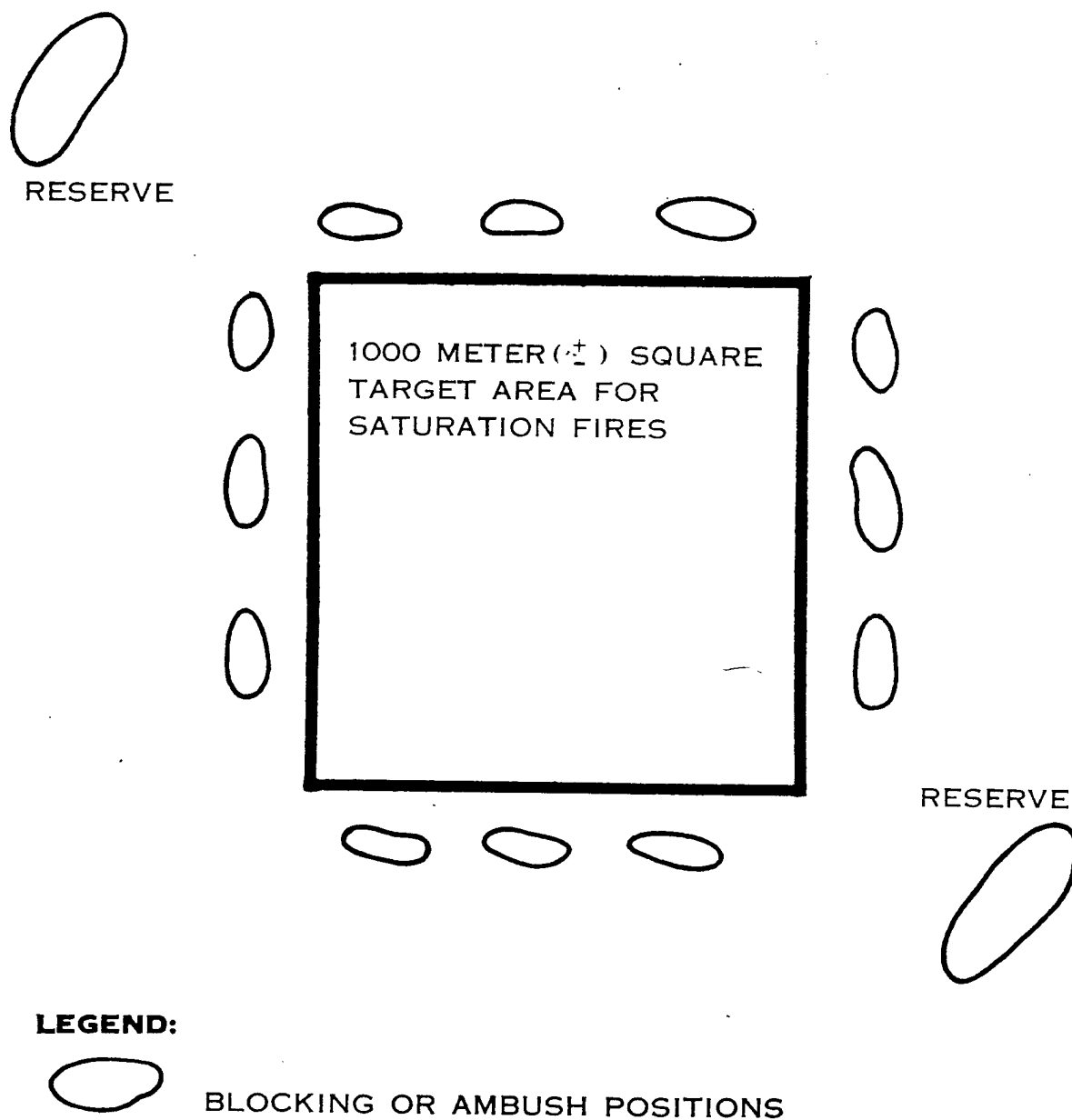


Fig. 1--Fire Flush<sup>2</sup>

<sup>2</sup>U. S., Department of the Army, Counterguerrilla Operations, Field Manual 31-16 (Washington: Department of the Army, 1963), p. 72.

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2. Tightening the noose (Figure 2).
3. Fragmenting the disc (Figure 3).
4. Hammer and anvil (Figure 4).<sup>3</sup>

Field artillery can play a very important role in the destruction of the guerrilla force. A need for detailed fire coordination exists, though, because the target area is completely encircled by friendly troops.

The pursuit is similar to the pursuit in conventional warfare. Figure 5 depicts the pursuit operation. Artillery can play an important role in the pursuit. Field Manual 6-20-2 states, "Artillery is invaluable in the pursuit of escaping guerrilla elements. . . . Often a few rounds will serve to turn retreat or 'last-ditch' defense into surrender."<sup>4</sup>

Generally, a counter guerrilla military organization will be assigned an area of operations encompassing a political subdivision of the area. Within the political area, the organization will establish a combat base from which to operate. This organization will assign definite areas of responsibility to subordinate units and require each subordinate element to establish combat bases in its assigned area.<sup>5</sup>

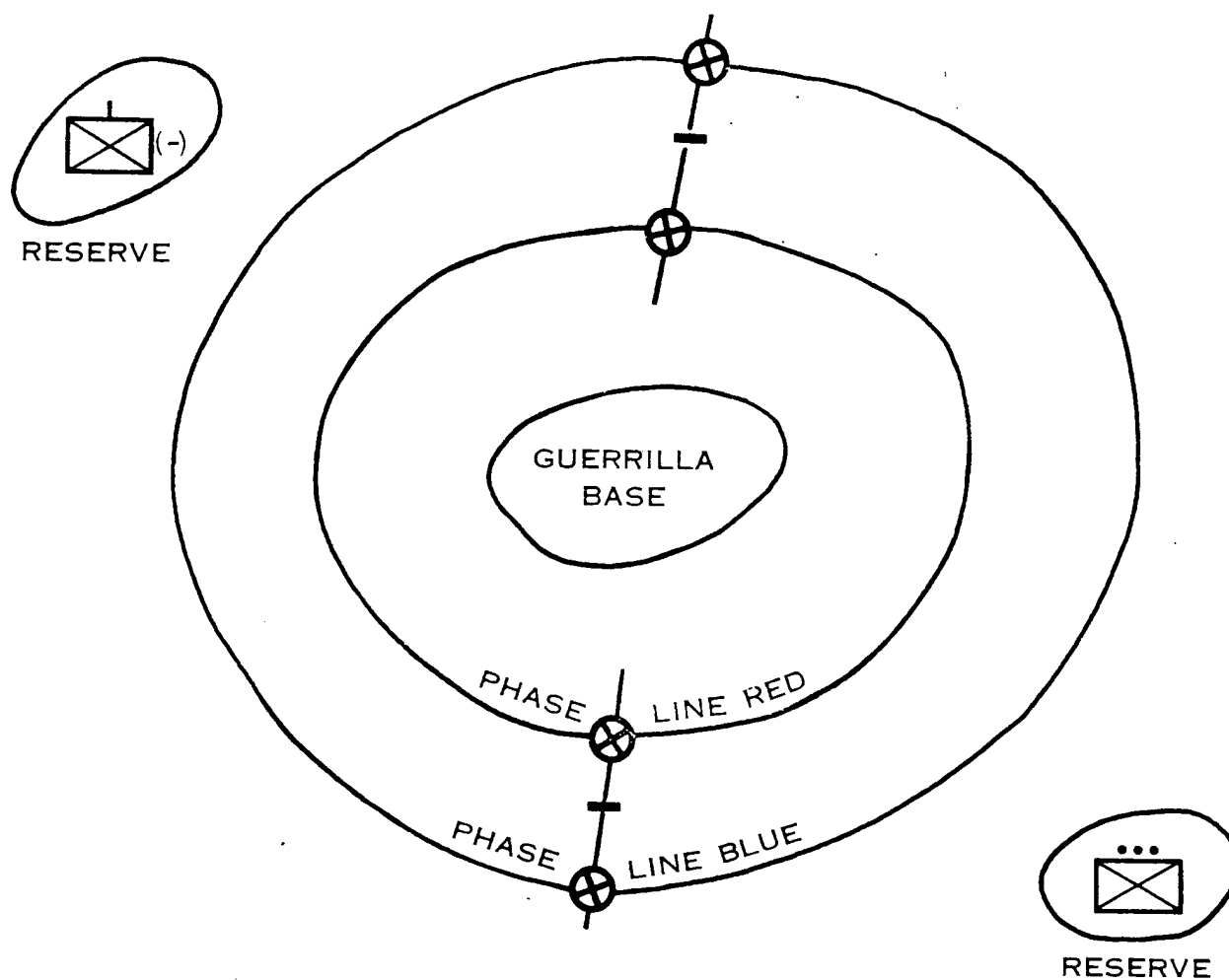
Figure 6 depicts such an area division of responsibility for a brigade. The counter guerrilla force clears the assigned sector by means of one of the offensive operations described and then controls the sector to

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<sup>3</sup>Final Draft Manuscript; Special Warfare Operations, op. cit.,  
p. 71.

<sup>4</sup>U. S., Department of the Army, Field Artillery Tactics, Field Manual 6-20-2 (Washington D. C.: Department of the Army, 1962), p. 82.

<sup>5</sup>Counter guerrilla Operations, op. cit., p. 24.



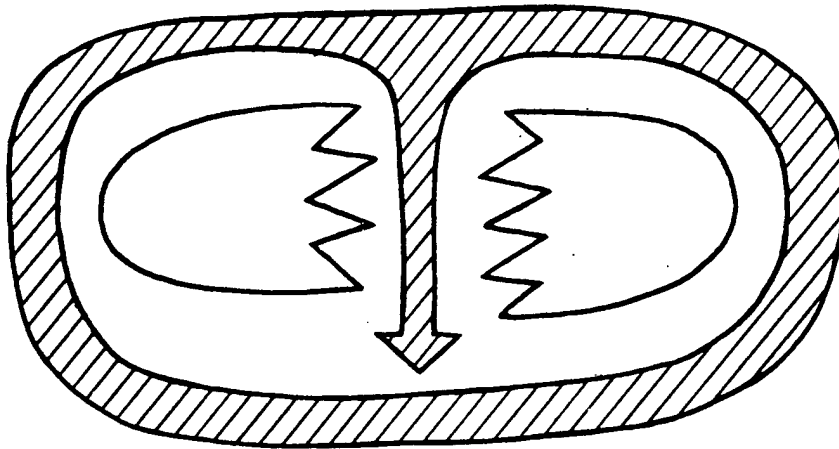
NOTE: Phase line blue is the initial line of encirclement.  
Phase line red is the line of contracted encirclement.

Fig. 2.--Tightening the noose<sup>6</sup>

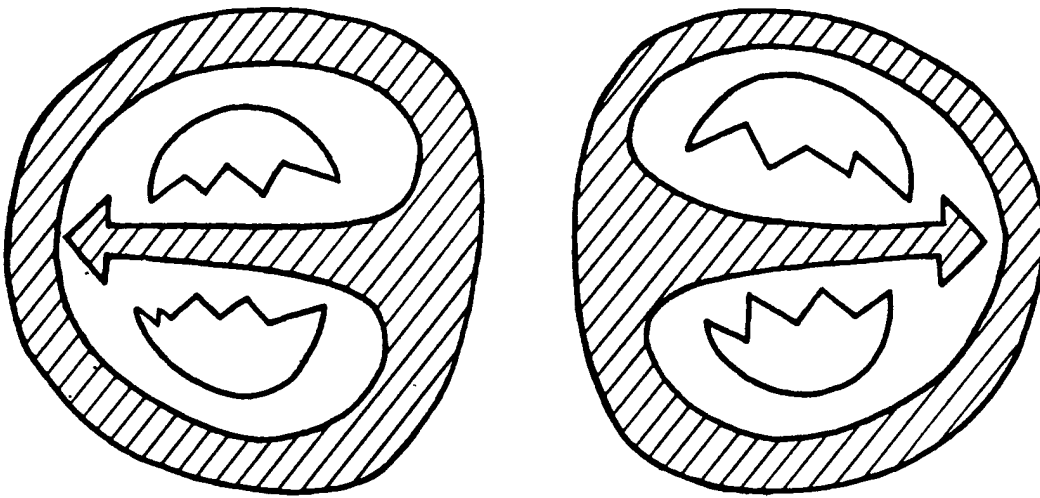
<sup>6</sup>Counter guerrilla Operations, op. cit., p. 65.

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A. FIRST BISECTION

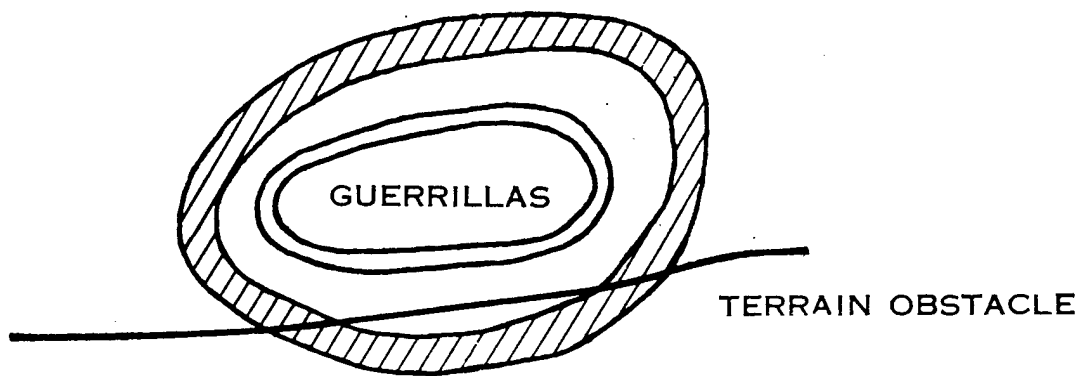


B. SECOND BISECTION

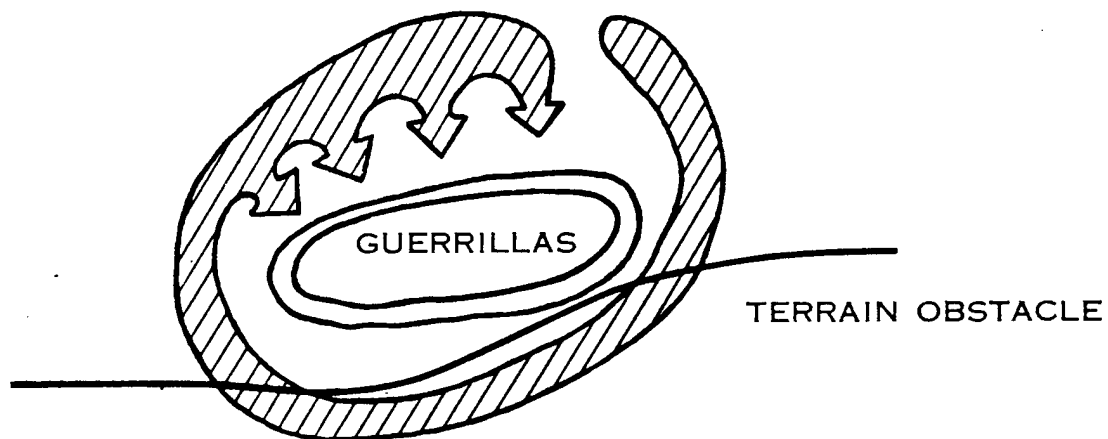
Fig. 3.--Fragmenting the disc<sup>7</sup>

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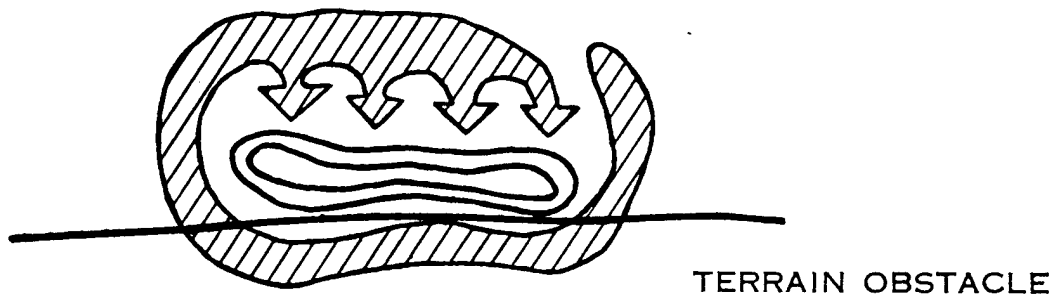
<sup>7</sup>Ibid., p. 66.



A. ENCIRCLEMENT COMPLETE



B. HAMMER ACTION INITIATED



C. FINAL CRUSHING ACTION

Fig. 4.--Hammer and anvil<sup>8</sup>

<sup>8</sup>Ibid., p. 68.



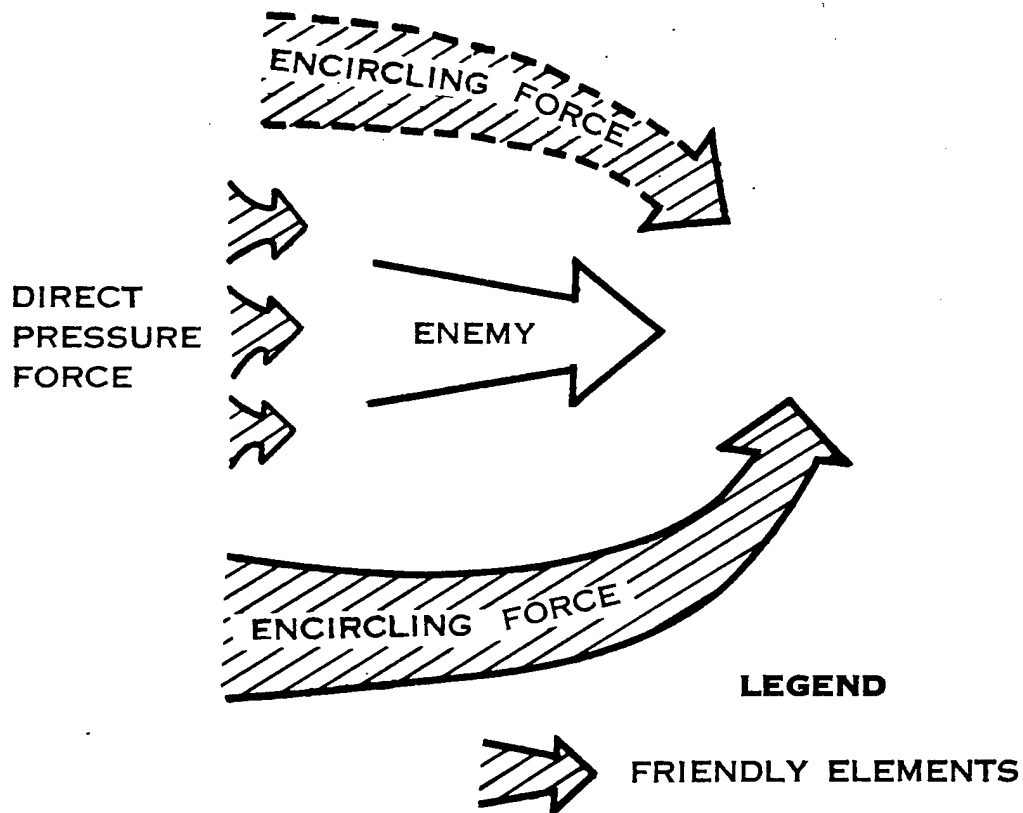
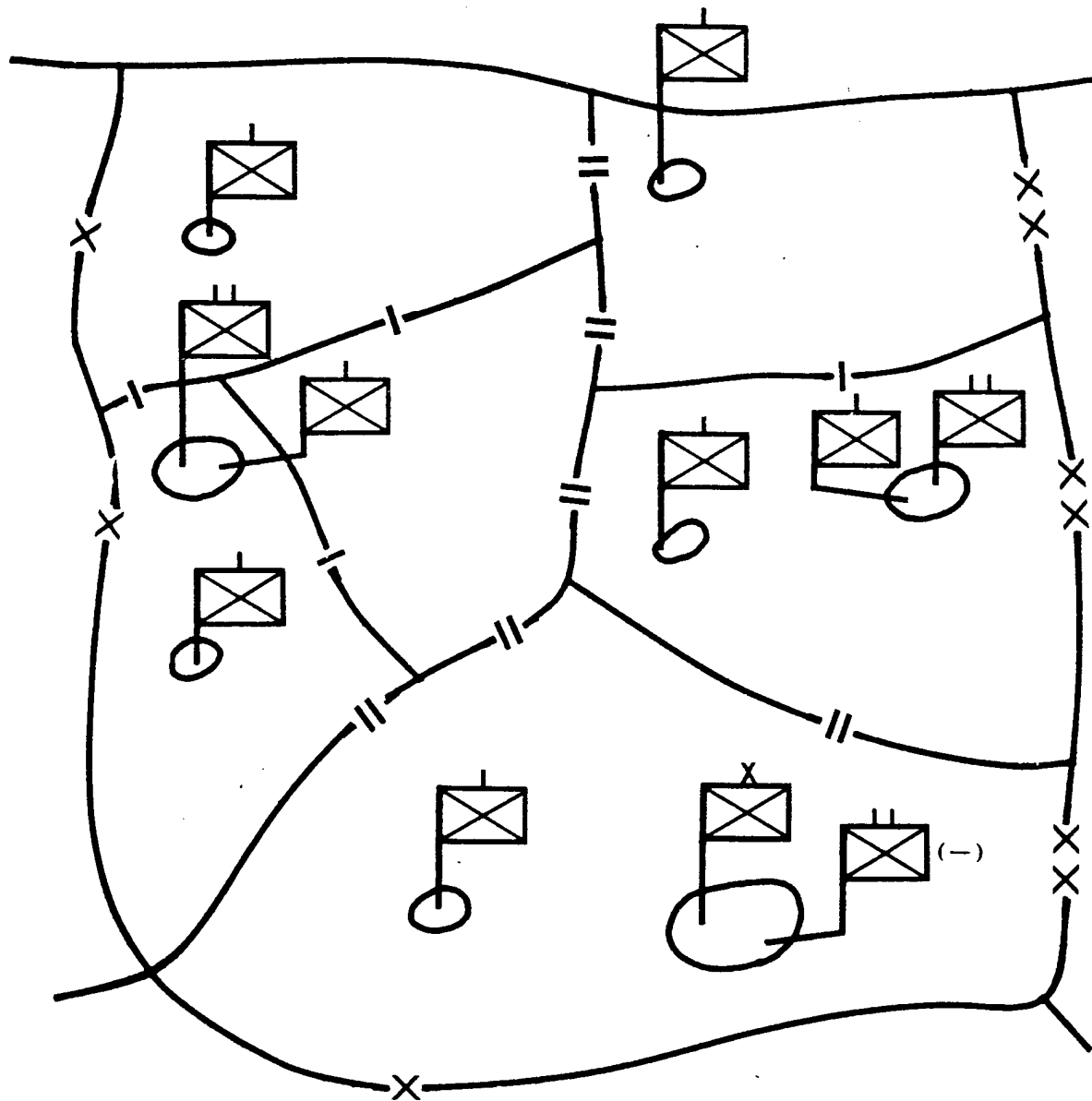
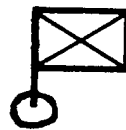


Fig. 5.--Pursuit<sup>9</sup>

<sup>9</sup>Ibid., p. 69.



## LEGEND:

COMBAT  
BASEFig. 6.--Schematic Brigade Area of Operations<sup>10</sup><sup>10</sup>Ibid., p. 25.

prevent large groups of guerrillas from regrouping within the sector. Upon clearing an area, the units move to adjacent areas and repeat the operation. This operation of clearing an area of guerrillas and then establishing control over the area, is called, appropriately, a "clear and hold" operation.

There are two characteristic properties of all counter guerrilla operations which can be concluded from the above discussion. First, there is a need for surprise and secrecy. Fighting an elusive enemy, which relies heavily on the local population for information, the troops occupying the blocking positions or the encircling positions must occupy their positions without the guerrilla's becoming aware of the impending operations. Hence, there is a requirement for the counter guerrilla force to have speed or mobility superior to that of the guerrilla and a requirement to thoroughly brief all counter guerrilla personnel involved in the operation and yet insure that guerrillas are not informed of the attack. Secondly, a need exists for a reserve at all times by which decisive action can be taken at the proper time.

In summary, the essential elements of counter guerrilla warfare are the same as those of guerrilla warfare. The old adage of "to fight fire with fire" or a variation of another, "it takes a guerrilla to catch a guerrilla" might apply. Speed and surprise are certainly essential to all operations. Table 1 compares some of the characteristics of guerrilla and counter guerrilla warfare.

#### A Type United States Counter guerrilla Force

To properly present an analysis of the use of field artillery in counter guerrilla warfare, it is necessary to assume a type United

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TABLE 1

## CHARACTERISTICS OF GUERRILLA AND COUNTERGUERRILLA WARFARE

Characteristic	Guerrilla Warfare	Counter guerrilla Warfare
1. Target	1. Primarily facilities, supply lines, communications; personnel are secondary	1. Primarily personnel.
2. Use of sabotage and demolition devices (including anti-vehicle mines)	2. Extensive	2. Negligible
3. Surprise, stealth, deception	3. Key to success of operation	3. Same
4. Use of anti-personnel mines	4. Extensive	4. Same
5. Movement	5. Must be very rapid, mostly on foot. Advantage taken of fading into populace and retreating to defensive refuge.	5. Must be very rapid. Has advantage of better communications, superior mobility, by use of land and water vehicles and aircraft.

<sup>a</sup>U. S., Office Chief of Ordnance, Development of Weapons for Guerrilla and Counter guerrilla Warfare (U), Technical Information Report J (Washington, D. C.: US Government Printing Office, 1962), pp. 8-9.

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States force which would be supported. There is no United States organization designed specifically for counter guerrilla operations.<sup>11</sup>

At a World Wide Combat Arms Conference at Fort Leavenworth in June 1962, it was stated by the Committee, headed by Maj. Gen. S. R. Larsen, on counter guerrilla operations that the "limitations imposed on the United States Army by strength ceilings and budgetary considerations do not permit the luxury of maintaining forces designed solely for counter guerrilla operations."<sup>12</sup> If and when Phase III<sup>13</sup> of counter-insurgency is reached, a tailored force, formed from available units would be formed.

For the purpose of this paper, a brigade size force is assumed since this is the size force which the U. S. Army visualizes will be used in counter guerrilla operations. A few U. S. Army brigades receive

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<sup>11</sup>As stated in The Dictionary of United States Army Terms (Washington, D. C.: U. S. Department of the Army, 1963), p. 412, the mission of the U. S. Army Special Forces is "to train, organize, supply, direct, and control indigenous forces in guerrilla warfare and counterinsurgency operations, and to conduct unconventional warfare operations." Therefore, the Special Forces do not have the mission to conduct counter guerrilla operations but only to train indigenous forces in counter guerrilla operations.

<sup>12</sup>U. S. Continental Army Command, World Wide Combat Arms Conference II (U), Vol II (3 vols.; Washington, D. C.: U. S. Continental Army Command, 1962), p. 197.

<sup>13</sup>The concept of employment of United States military forces during the three phases of insurgency is described in the Joint Chiefs of Staff Publication No. 2, Unified Action Armed Forces (Washington, D. C.: U. S. Government Printing Office, 1959), p. 110.1. During Phase I, the Military Assistance Advisory Group (MAAG) or Mission in the threatened country would be reinforced by selected counterinsurgency forces. If no MAAG or Mission existed in the country concerned, the country would be encouraged to request a MAAG or Mission or a tailored counterinsurgency force. During Phase II, United States assistance would be augmented to include operational assistance. This would include small unit advisors, instructors, training units and necessary equipment. During Phase III, United States tactical forces may be deployed to operate with indigenous forces in a coordinated military campaign.

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supplemental training to prepare them for counter guerrilla operations. Major General Peers stated the U. S. Army has in being what is known as "back-up brigades" to meet the requirement of supplying United States tactical forces during Phase III of counterinsurgency. These brigades are located in designated Strategic Force Divisions and are area-oriented and counterinsurgency trained. The entire 25th Infantry Division is deployed in Hawaii under the back-up brigade principle.<sup>14</sup> Also, the U. S. Army Command and General Staff College, in a study of operations against irregular forces, visualized a brigade size force being employed (Figure 7).

Naturally, the area of operations will have a great bearing on the type units assigned to the brigade. There are wide variations in the nature of the terrain in the area of the tropics. The main consideration for the type maneuver elements assigned to the brigade is mobility. As was stated earlier, the counter guerrilla force must have superior mobility to that of the guerrilla force. The mobility of U. S. forces in terms of time to reach a given point in an area of operations containing ideal terrain can be listed, in descending order of mobility, as follows:

1. Airborne.
2. Airmobile.
3. Armored.
4. Mechanized.
5. Infantry.

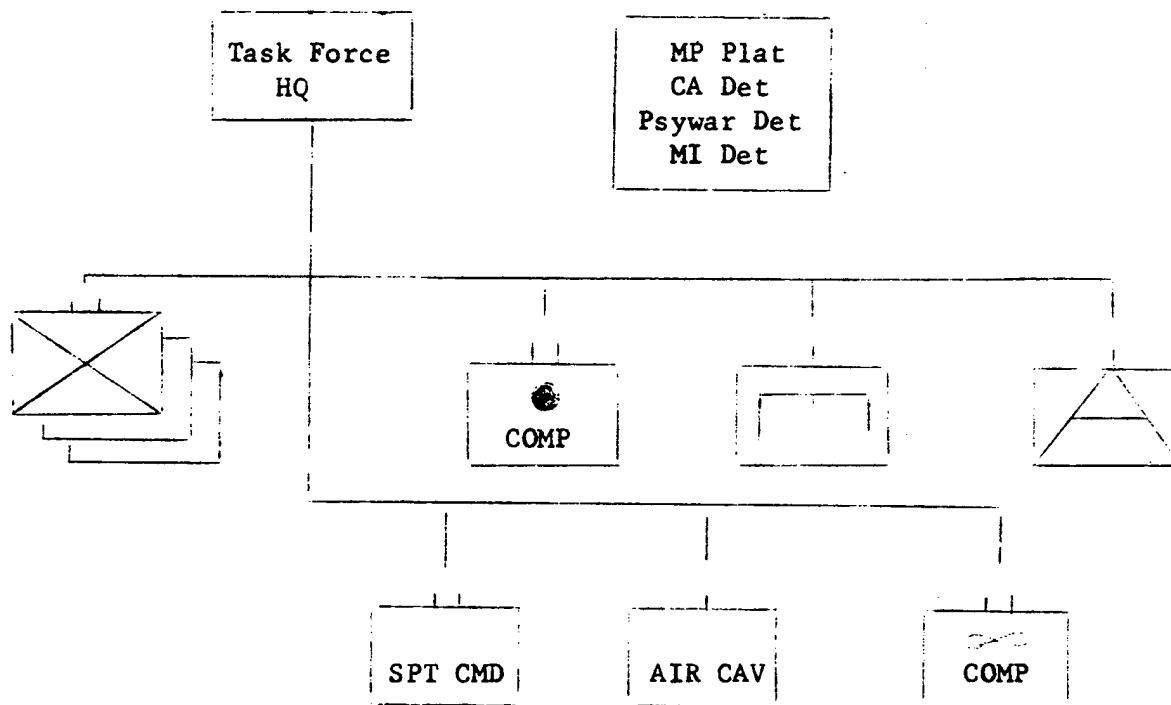
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<sup>14</sup>W. R. Peers, "Meeting the Challenge of Subversion," Army, November 1964, p. 95.

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forces<sup>15</sup> Fig. 7--Sample task force for operations against irregular

<sup>15</sup>U. S., Army Command and General Staff College, A Detailed Concept for Employment of US Army Combat Units in Military Operations Against Irregular Forces (U), (Fort Leavenworth: U. S. Army Command and General Staff College, 1962), p. 197.

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One might argue that airmobile operations are faster than airborne operations because of the relative simplicity of airmobile operations and because the airmobile forces are landed in a tactical group and normally retain their mobility. This is true for operations within a relatively short radius from the base of operations but airborne operations are faster and thus have superior mobility in operations at great distances from the base of operations.

It is difficult to visualize the movement, in dense jungle, of any ground vehicles without extensive engineering effort being employed to build and improve roads and trails. This is a time consuming process and negates any opportunity for surprise--an essential element of counter-guerrilla warfare. The extremely mountainous terrain existing in portions of the tropics also prohibits the extensive use of ground vehicles. Guerrillas habitually utilize the most difficult terrain for their operations to offset their lack of modern weapons and equipment. Because of this practice, an infantry brigade, consisting of three infantry battalions which have an airmobile capability, is assumed to be the type force involved in the operation. The force, based on present Tables of Organization and Equipment (TOE), is organized as shown in Table 2.

The brigade is further assumed to be augmented with appropriate units such as military intelligence, civil affairs, psychological warfare units, military police, signal units, air defense units, and sufficient aircraft to give the brigade an airmobile capability of lifting up to two battalions at one time.

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TABLE 2

## A TYPE COUNTERGUERRILLA FORCE

Unit	TOE	Strength		
		O	WO	EM
1. Separate Infantry Brigade (minus the Armed Cav Troop)	7-100E			
a. Headquarters and Headquarters Company	7-102E	29	1	184
b. Aviation Company	1-47E	14	24	97
c. Engineer Company	5-127E	5	1	194
d. Support Battalion	29-75E	50	10	661
e. Air Cav Troop	17-108E	12	19	112
2. Three Infantry Battalions	7-15E	111	6	2373
Total		221	61	3621

## Summary

The area of operations, as described in Chapter I, is characterized by dense jungles, mountains, swamps, poor roads, and a lack of railroads and bridges. The operation takes place against an enemy who fights a peculiar type war; against an enemy who favors night attacks, relies heavily on surprise and will not stand and fight a pitched battle; against an enemy who attacks only when he is assured of success; against an enemy who is able to blend into the local populace; and against an enemy who, as Major Love said, is extremely "vulnerable to artillery fire because of his lack of prepared defenses, armor, and

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individual protective gear."<sup>16</sup> To counter this enemy we have a highly sophisticated force, of brigade size, which must ferret out the guerrillas and either capture or destroy them.

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<sup>16</sup>John C. Love, "Rocket Artillery: A New Challenge," Marine Corps Gazette, July, 1964, p. 29.

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## CHAPTER III

### ARTILLERY FIREPOWER

#### Mission

Before determining the requirements of artillery<sup>1</sup> weapons to be used in counter guerrilla warfare, it is necessary to examine the missions of the artillery in counter guerrilla warfare.

The mission of the artillery in counter guerrilla warfare is the same as in conventional warfare; that is, "to support maneuver elements by destroying or neutralizing those targets most dangerous to the supported arms."<sup>2</sup> Even though the mission is the same, the manner in which the mission is accomplished differs from that of conventional warfare, as was pointed out earlier and as will be discussed in detail in this chapter. A word of caution is interjected by the MAAG, Vietnam, though, when the chief stated: "Artillery is a major component of ARVN Army, Vietnam firepower not presently possessed by the VC Viet Cong and if properly employed can greatly assist the CI counterinsurgency effort. However, since fire power is a double-edged weapon in a 'peoples' war,

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<sup>1</sup>For the remainder of the paper, the word "artillery" refers to "field artillery".

<sup>2</sup>U. S., Department of the Army, Field Artillery Tactics, Field Manual 6-20-1 (Washington, D. C.: Department of the Army, 1961), p. 4.

artillery fires must be carefully planned and executed to avoid inflicting casualties and damage among the civilian populace."<sup>3</sup>

Fires used to accomplish the artillery's mission are classified into four categories: destruction fire, neutralization fire, harassing fire, and interdiction fire. Destruction fire is concentrated on materiel or objects which are to be destroyed beyond use. Neutralization fire is delivered to hamper and interrupt the fire of enemy weapons, and to reduce freedom of movement. Harassing fire is designed to inflict losses or to disturb enemy troops by the threat of losses, to limit their movement, and lower their morale. The intensity of the fire delivered is less than that of neutralization fire. Interdiction fire is placed on an area or point to prevent the enemy from using the particular area or location.<sup>4</sup>

#### Use of Artillery in Counterguerrilla Warfare

Artillery can be used effectively to support infantry units in clearing sectors; that is, in support of offensive operations. It can also be used effectively for other purposes which are described below:

1. Artillery can be used to support the "fire flush" operation. The artillery is positioned to be able to cover the area being flushed. An intense saturation type fire is placed in the area to cause the guerrilla to attempt to move from the area and become engaged by the troops in the blocking or ambush positions. Because the guerrilla force may

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<sup>3</sup>Military Assistance Advisory Group, Vietnam, Tactics and Techniques of Counterinsurgent Operations (U) (Vietnam: Military Assistance Advisory Group, 1963), p. III I-1.

<sup>4</sup>U. S., Department of the Army, Field Artillery Cannon Gunnery, Field Manual 6-40 (Washington, D. C.: Department of the Army, 1960), p. 310.

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not be accurately located, accurate fire is not required. Also, likely routes of escape can be covered by artillery concentrations. To support the fire flush, the artillery must be capable of moving into position quickly, covering the area, and firing rapidly.

2. In the encirclement operation, neutralization fires are employed against guerrillas to inflict losses and reduce the combat efficiency of the guerrillas in the encirclement. In the support of the encirclement, fire coordination becomes a major problem. Regardless of the method used to destroy the encircled guerrillas, i.e., "tightening the noose," "hammer and anvil," or "fragmenting the disc," the artillery impact area becomes smaller and smaller, and fire control becomes more difficult. A round which is safe for one unit can be unsafe for a unit on the opposite side of the encirclement. Accuracy of fire becomes increasingly important. As in the fire flush, likely avenues of escape can be covered and the artillery must be capable of moving into position quickly and firing rapidly and accurately.

3. In the pursuit, a long range capability for the artillery becomes important. A long range capability permits the artillery to keep the guerrillas under constant pressure by fire without the necessity of displacing frequently. The long range fires can also be used to block avenues of escape. In the pursuit, mobility (to be discussed later) is also of great importance.

4. Harassing and interdiction type fires are used in conjunction with ground operations to keep the enemy on the move when his location is known.<sup>5</sup> The demoralizing effect of artillery fire on guerrillas often

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<sup>5</sup>Tactics and Techniques of Counterinsurgent Operations (U), op. cit., p. III I-4.

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justifies use of artillery even though there is little possibility of inflicting any material damage.<sup>6</sup>

5. Artillery is also used to deceive the enemy. Artillery fire which is delivered into areas other than those in which the counter guerrilla forces are operating can deceive the guerrillas and increase the element of surprise by giving the guerrillas a false sense of security. At the same time, the fires of the artillery can cover the noise of the counter guerrilla force moving into the guerrilla area. Naturally, the deception area must be clear of friendly forces and civilians.<sup>7</sup>

6. When within supporting range, artillery is used to aid in the defense of villages and outposts. Preplanned fires can be prepared for each area within range so that supporting fires can be provided quickly.<sup>8</sup>

7. Artillery can also be used for counter-ambush fires. Fires are preplanned along routes used by friendly forces and are delivered on call. This procedure can effectively discourage the establishment of ambushes by guerrillas.<sup>9</sup>

8. In rugged terrain, artillery can be utilized to assist ground navigation. The use of artillery high bursts can assist the counter guerrilla force in gaining and maintaining their orientation.<sup>10</sup>

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<sup>6</sup>U. S., Army Combat Developments Command, Combined Arms Agency, Final Draft Manuscript: Special Warfare Operations, Field Manual 31-15 (Fort Leavenworth: U. S. Army Combat Developments Command, 1964), p. 38.

<sup>7</sup>Tactics and Techniques of Counterinsurgent Operations (U), op. cit., p. III I-5.

<sup>8</sup>Ibid.

<sup>9</sup>Ibid.

<sup>10</sup>Ibid.

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9. The threat of the use of artillery can sometimes clear an area of guerrillas without the need for infantrymen, as has happened in Vietnam. A report from Vietnam states: "There is considerable evidence that movement of an artillery piece into a new area sometimes causes the Viet Cong to evacuate the area within range of the weapon."<sup>11</sup>

In the counter guerrilla operations in Vietnam, artillery is used in a manner that is different from the accepted U. S. Army doctrine. Decentralization of control and the employment of small fire units characterize the use of artillery in Vietnam. Firing units, whether given the mission of supporting maneuver forces or protecting villages, are habitually in a firing position and ready to fire. Frequently, the artillery is positioned inside an operational base or a village and is given the mission of supporting all the counter guerrilla forces within range. In such instances, it is common to have the pieces prepared to fire in different directions for defense against guerrillas attacking from any direction. Although artillery positioned within an operational base or built up area is often able to support a counter guerrilla force, it usually accompanies the force to within continuous supporting range.<sup>12</sup>

The MAAG, Vietnam, has stated that the following basic principles must always be followed by artillery which is supporting a maneuver force:

1. To be effective, the forward observer must operate at the basic combat unit level: the maneuver company or with the separate platoon or patrol. Full utilization of all artillery observers must be

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<sup>11</sup>U. S., Continental Army Command, Counterinsurgency, Lessons Learned (U), Continental Army Command Pamphlet 515-4 (Fort Monroe: U. S. Continental Army Command, 1962), p. 198.

<sup>12</sup>Tactics and Techniques of Counterinsurgent Operations (U), op. cit., p. III I-2.

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made to provide each basic combat element an observer. The observer cannot effectively acquire and attack targets if he is retained at the infantry battalion level, and, in effect, performs liaison officer functions. In the jungles, swamplands, and mountainous areas, artillery air observers are vital to obtain maximum effectiveness from artillery fires. Every effort should be made to keep air observers over the area throughout daylight hours.

2. Artillery units must be prepared to displace at all times. During displacements, units must be prepared to halt and fire from the road. Displacement by helicopter greatly enhances the role of artillery support of deep penetrations and long range independent operations.

3. The most effective artillery fires are those which are observed and adjusted onto the target. Unobserved fires should be used only in areas void of friendly or neutral civilians and in areas which are known to be frequented by guerrillas.

4. Care must be taken when firing in unsurveyed or poorly mapped areas to prevent the first rounds from landing on friendly troops or civilians. The preferred technique is to use, for the first round, a high air burst of white phosphorous or smoke for observer orientation.

5. Because of the widely dispersed nature of counter guerrilla warfare and the many, small, independent maneuver elements operating simultaneously throughout the area, it is desirable to establish an inter-battalion integrated communication system. Within an operational area, the forward observer must have the capability to call for and adjust the fires of any artillery unit within supporting range.<sup>13</sup>

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<sup>13</sup>Ibid., pp. III I-2 - III I-3.



## Artillery Capabilities and Problem Areas

Artillery has certain capabilities which must be noted. These capabilities, which are applicable to any type operation, include the following:

1. Artillery can be employed in any type of weather and during the hours of darkness as well as in daylight. This capability is of particular value in counter guerrilla warfare since the guerrilla habitually uses the hours of darkness and poor visibility to cover his attacks. This capability is especially useful for the protection of outposts and villages.

2. Artillery is more accurate than tactical air. When controlled by an observer, artillery fires can be placed on a target with a high degree of accuracy. Even when the observer can not see a target but the target has been located by some other means, such as sound, relatively accurate fires can be placed on the target.

3. Artillery fires can be shifted rapidly and massed within a large area without displacing the weapons. "The reaction times possible with artillery fires and flexibility of shifting those fires over wide areas provides a responsive and effective means of countering guerrilla action."<sup>14</sup>

4. Artillery can fire on targets without exposing the weapons to direct enemy observation. When the indirect fire capability of the weapon is used, the guerrilla is unable to ascertain the location of the artillery. Without radar, which a guerrilla force does not normally have, the guerrilla is unable to detect the firing location of the

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<sup>14</sup>Final Draft Manuscript: Special Warfare Operations, loc. cit.

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artillery unless he is near enough to the position area to see the flash when the weapon is fired.

5. Artillery can fire on targets in defilade. Once again, this is because of the nature of the indirect fire system and the inherent capability of most artillery weapons to fire high angle fire which permits them to attack targets which are in defilade.

6. Artillery can fire on targets without adjustment and hence achieve surprise. Due to recent refinements in the fire direction procedures and the firing tables, the probability of first round hits has increased immeasurably during the past few years. To fully exploit this capability, though, a meteorological section would be required to determine the conditions of the weather for use in the fire direction center.

7. Artillery can fire a variety of shells and fuzes. Most tube artillery weapons can fire point detonating, proximity, time and delay fuzes and illuminating, smoke, and leaflet, as well as high explosive shells. Each of these fuzes and shells has a specific place and time for use in counter guerrilla warfare. Because the guerrilla normally attacks at night, illuminating shells are of great value. One of the lessons learned in Vietnam is that artillery illuminating missions acts as deterrents to the Viet Cong and gives a psychological boost to the village defended.<sup>15</sup> Time, proximity, and point detonating fuzes are of little value in a dense jungle which has thick canopy since the shells burst above the tree tops or in the tree tops, but they are of considerable value on the plains or in the open. Delay fuzes are of great value in the dense jungle since the shell explodes after it has passed through the canopy. Smoke is useful for aiding an observer in the adjustment

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<sup>15</sup>Counterinsurgency, Lessons Learned (U), op. cit., p. 331.

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of fire in the dense jungle or to use as marking rounds in aiding patrols in moving through the jungle.

There are certain problem areas in the use of artillery in jungles and mountains and peculiar to counter guerrilla warfare. The most important problem areas are:

1. Ground observation of fire is restricted because of the dense growth. Hence, targets are difficult to locate and adjustment of fire is difficult.

2. The artillery will be supporting relatively small units. Because of the nature of the warfare, squads, platoons, or companies will be conducting most of the operations and these small units will require artillery support.

3. Security of the position area becomes of extreme importance. Because of the nature of the war, there is no front or rear; and, therefore, the artillery commander must pay close attention to the security of his area. An all around defense is absolutely necessary.

4. In jungle areas, there is a scarcity of good position areas. Position areas must be cleared prior to the arrival of the weapons to avoid attack before the weapons are ready to fire.

5. Normally, there is excessive mask<sup>16</sup> in the position area. This applies to the mountainous terrain as well as to the jungle where tree tops restrict the firing.

6. Normally, there is a shortage of accurate maps. Most of the

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<sup>16</sup>"Mask" refers to natural or artificial terrain features, such as hills, trees, or buildings which, because of their proximity to the position area, restrict firing. The weapons must fire above a certain elevation to avoid hitting the terrain features.

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underdeveloped portions of the world are either unmapped or poorly mapped.<sup>17</sup>

7. Ammunition resupply becomes difficult in the mountains and jungle.
8. Movement by surface means is difficult.
9. Communication becomes a serious problem, especially in the jungle.

### Solutions to Problem Areas

How can the problems presented be solved other than by stating that the commander must use his imagination and ingenuity? This section presents possible solutions, for use as the basis for the determination of desirable characteristics for artillery weapons, to these problem areas. The mobility problem is considered in the next chapter.

The first problem area is that of observation. Often, it will be necessary for the observer to get within a hundred meters of the target to be able to see it. Colonel T. N. Dupuy, in an article in Army wrote that in his experiences in the jungles of Burma in World War II, "usually there was absolutely no way to bring fire on most targets in the jungle save by a 'creeping' registration in which the forward observer brings the center of impact close enough to have occasional fragments whistle over his own head."<sup>18</sup> An aerial observer can play an important role in adjusting fire in the jungle. The need for aerial observers was recognized

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<sup>17</sup>This statement is a result of a study by the author of the World Small Scale Map Series (Smaller than 1:600,000), prepared by the National Topographic Map Industry Control Point (Washington, D. C.: U. S. Army Map Service, 1964).

<sup>18</sup>Trevor N. Dupuy, "Forward Observer in the Jungle," Army, September 1963, p. 70.

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during the jungle fighting in the Pacific during World War II. An Army Ground Forces Report in 1944 stated, "The plane is an absolute necessity for effective jungle artillery operations."<sup>19</sup> As pointed out in a Marine Corps Gazette article, the air observer should be able to perform fire direction duties in addition to observing fires. With a few items of graphical equipment, he could convert observer corrections into fire commands which could be sent directly to the guns.<sup>20</sup> In this manner many valuable seconds would be saved in a type war in which speed is of the utmost importance. But it must be kept in mind that the ground observer is the primary observer. As the Army Ground Forces Report put it, "The ground observer is the principal and basic means of observation and conducting fire. His success depends upon his ingenuity, his experience, his energy and his luck."<sup>21</sup> The aerial observer can aid the ground observer in adjusting fire. Field Manual 6-20-2 states that often the ground observer will be able to hear the rounds fall but will be unable to see them, even though he can see the target. The aerial observer will be able to see the rounds but will only know the approximate location of the target. A combination of their sensings will give the fire direction center a better picture of the adjustment and will speed up the delivery of fire.<sup>22</sup>

Therefore, to identify and adjust fire on targets, experienced observers are needed who must commit the so-called "sin" of "creeping" in

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<sup>19</sup>U. S., Army Ground Forces, Artillery Observation in the Jungle, Training Notes 3 (Washington, D. C.: U. S. Army Ground Forces, 1944), p. 1.

<sup>20</sup>C. R. Leach and C. J. O'Shea, "Artillery vs Guerrillas," Marine Corps Gazette, September 1962, p. 51.

<sup>21</sup>Artillery Observation in the Jungle, loc. cit.

<sup>22</sup>Field Artillery Tactics, op. cit., p. 76.

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their adjustments and who are prepared to move the impact of the rounds close in to their own positions. Aerial observers are needed who are capable of converting observer corrections into fire commands, and sufficient observers as needed to accompany each of the basic tactical units so the observers are far forward. The latter establishes a requirement for more forward observer sections than are included in the present tables of organization.

The second problem area is the necessity to support relatively small units which requires that the artillery be prepared to support the operations by platoons or even sections. A report from Vietnam states that artillery in support of counter guerrilla operations is predominantly employed by platoons. These platoons are generally widely dispersed, often not within mutually supporting distances.<sup>23</sup> In a few areas in Vietnam, even single howitzer sections have been employed. Single howitzer employment is found to be useful in Vietnam in areas where mobility is limited by a complete lack of roads and in areas of intense guerrilla activity. Single howitzer employment is justified because of the great respect the Viet Cong have shown for the capability of artillery weapons.<sup>24</sup> Such use is contrary to the employment of artillery in conventional warfare where the massing of artillery fires is desirable. But because of the nature of guerrilla warfare, different methods must be employed. Since the guerrilla attacks in small size units in difficult terrain, very few lucrative targets, which require massed artillery fires, present themselves. Also, as Field Manual 6-20-2 states: "Most artillery targets are fleeting and temporary. This situation eliminates the need

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<sup>23</sup>Tactics and Techniques of Counterinsurgent Operations (U), op. cit., p. III I-2.

<sup>24</sup>Counterinsurgency, Lessons Learned (U), op. cit., p. 198.

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/in counter guerrilla warfare/ for massed fires and instead, requires rapid precision fire."<sup>25</sup> Therefore, although the breaking of the battery down into smaller units is heresy to the artilleryman, actually it is a desirable practice in guerrilla warfare. The commander is simply applying sufficient firepower to accomplish his mission by insuring that the supported unit(s) have the necessary artillery firepower readily available. The employment of artillery by platoons or sections gives rise to two minor problems. First, there is a need for more fire control equipment in the battalion, to include communications and forward observer sections to support each of the firing units. Second, security of the position area becomes more of a problem than in conventional warfare. The solution to the first is obvious. The solution to the second is discussed below.

In the support of small unit operations artillery, employed by platoons or batteries, may be attached to the supported force and therefore must be prepared to operate far removed from its higher headquarters.<sup>26</sup> Hence, the operations will be decentralized, as opposed to the centralized operations in conventional warfare. The artillery fire units must be prepared to operate independently. They must be properly equipped to perform the necessary fire direction and provide the necessary local security.

The third problem is position area security. A problem present in conventional warfare, it becomes intensified in counter guerrilla warfare due to lack of definite front lines and decentralized employment of the artillery. To limit the length of the perimeter around the position area, the weapons must be closer together than in open terrain or in

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<sup>25</sup>Field Artillery Tactics, op. cit., p. 81.

<sup>26</sup>Counterinsurgency, Lessons Learned (U), op. cit., p. 201.

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conventional warfare. When not actually firing a mission, the weapons must be positioned so the fire unit covers a complete circle and is ready to deliver direct fire in defense of the position area. As in conventional warfare, the artillery, whenever practicable, should be located within the area occupied by the infantry reserve. This permits the artillery to make use of the security offered by the riflemen. The position area must be encircled by warning devices, trip flares, and personnel mines. When the artillery is operating alone, away from the infantry, provision of personnel for manning the perimeter becomes a problem. This is especially true if the artillery is operating by platoons which are not within supporting distance of other platoons.

As stated, this is no new problem. Artillery units have always experienced the need for position area security. The solution will depend on the method of employment. If the artillery is employed as a battalion, the defense of the batteries must be integrated into a battalion defense system. If the batteries are employed separately or platoon size units are employed, not within an infantry area, each unit has to be augmented with security forces to give the artillery the security which it requires and thereby not take artillery crews away from their primary mission.

The fourth problem is a lack of good position areas. The artillery must support the infantry in any type of terrain. Often, in the jungles, position areas will have to be cleared. Clearing of position areas is time consuming work and, hence, is of little use in a surprise attack. When clearing is necessary, care must be taken to avoid disturbing the tree pattern, if possible. Position areas in the jungle are often surrounded by tall trees which present an excessive mask to the artillery. A tall mask requires the artillery weapon to be able to fire high angle fire in order to fire over the mask.

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The fifth problem is the shortage of accurate maps. The solution to this problem is one of fire direction training. Suffice it to say that the artillery is capable of firing accurately from observed firing charts<sup>27</sup>; and, although the lack of accurate maps is a problem, it can be overcome by the proper training of the fire direction personnel.

The last problem is one of ammunition resupply. Ammunition resupply presents a problem because of the difficult terrain encountered in the tropics. Depending on the terrain and road net, ammunition can be resupplied by land vehicles, pack animals, or aircraft. Ammunition can be supplied to the position area by the same mode of transportation as used to transport the weapons to the area. Because of the difficult terrain which must be traversed, though, more time must be allotted for the movement, especially when the movement is by land vehicles or animals, than is allotted in more favorable terrain.

#### Desirable Artillery Weapon Characteristics and Personnel Requirements

Based on the problems discussed and their solutions, the following is a list of the desirable characteristics of an effective artillery weapon as well as for certain personnel requirements, for counterguerrilla warfare:

1. The weapon must be relatively accurate. Although precision type fire missions will seldom be fired, the weapon must be accurate enough to support offensive operations where close-in fire support is required.

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<sup>27</sup>An observed firing chart is a chart (a grid sheet or even plain paper) on which the relative locations of the firing battery and the targets are established by the adjustment of fire (U. S., Department of the Army, Field Artillery Cannon Gunnery, Field Manual 6-40 [Washington, D. C.: Department of the Army, 1960/, p. 267).

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2. The weapon must be capable of firing various type fuzes and shells. The need for smoke and illuminating shells was shown. The effects of the dense jungles on the various fuzes was also discussed.

3. The weapon must be capable of firing high angle as well as direct fire. It must be able to fire high angle because of the excessive mask encountered in the mountains and the jungles and direct fire for defense of the position area.

4. The weapon should be able to shoot in a complete circle without shifting trails or else permit shifting of trails in a relatively short period of time. This capability is required for effective support of small units operations and for the defense of the position area.

5. The weapon should be capable of being converted from a traveling status to a firing status, in a relatively short period of time. Rapid emplacement is necessary to successfully attack the fleeting and temporary guerrilla target as well as permit the support of the normal surprise type attacks where it is mandatory that the artillery occupy the position at the latest possible time.

6. It should have the capability of firing at relatively long ranges as well as relatively short ranges. The long ranges are required for continuous fire support of patrols and combat units without the need for displacing. The short range is required for attacking close-in targets.

7. The unit must be capable of being employed by platoons. The need and desirability for platoon employment has been fully discussed earlier in this chapter.

8. The weapon system should have a relatively high rate of fire. Because of the fleeting nature of the target, it is necessary to deliver as heavy a volume of fire as practicable in the shortest time possible.

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Placing a heavy volume of fire on a target is normally accomplished by massing the fires of the battalion; but in an operation where batteries, and possibly platoons, are widely separated, massing of fires is not normally possible. Therefore, irrespective of manner of employment, the individual weapon should have a high rate of fire to insure a large volume of fire is placed on the target.

9. Sufficient observers must be available to insure that each unit which requires artillery fire support actually has observers.

10. Sufficient security personnel, whether organic or attached to the artillery unit, must be available to provide the necessary position area security.

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## CHAPTER IV

## MOBILITY

## General

The importance of surprise has been discussed previously and surprise can most easily be obtained through secrecy in planning and a mobility, during the execution phase, which is greater than that of the guerrilla. This chapter presents an analysis of the requirement of mobility for the artillery. Mobility, as it applies to artillery, is not limited to the physical movement of the weapon; that is, mobility is not related solely to time and space. Mobility can also be achieved through the use of long range fires. Artillery, because of its range, can reach far out and keep the guerrilla under constant fire as he moves without physically displacing the artillery weapons. This type of mobility is discussed in the preceding chapter the need for long range fires is presented. Chapter IV is concerned with only the physical aspects of mobility.

The ground mobility requirements are, of necessity, discussed in a manner slightly different from that used in discussing the firepower requirements. In the latter instance, the desirable capabilities are determined based on the use of the weapon. In discussing mobility, the desirable capabilities are known; and the type vehicle, or prime mover, or the characteristics of the artillery weapon which enhances its mobility are determined.

Two ground mobility capabilities are desirable for artillery in counter guerrilla warfare. First, the artillery must have a mobility capability which is at least equal to that of the supported force. This, in itself, is no problem since the maneuver elements, the infantry elements of the brigade force, are only 15% mobile.<sup>1</sup> Inherent in this requirement, though, are mobility needs which are peculiar to counter guerrilla warfare in the area of the world under consideration; that is, the artillery must be able to traverse dense jungles, traverse mountainous terrain, and have a stream crossing capability. The broad policy of the United States Army Artillery and Missile School on artillery mobility is that cross-country mobility is considered satisfactory if the artillery is able to give adequate support to the maneuver elements in all types of terrain, and it is desirable that the vehicle possess a water crossing capability, in order of priority, of swimming, floating, and fording.<sup>2</sup> The second capability, that of being helicopter transportable, is related to the first but is discussed separately.

#### Ground Mobility Requirements

Because guerrillas, whenever practical, select relatively inaccessible terrain, such as mountains, swamps, or jungles, as bases from which to conduct operations, counter guerrilla operations are essentially a matter for highly mobile units.<sup>3</sup> But, when confronted with an area having

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<sup>1</sup>U. S., Department of the Army, Rifle Company, Infantry Battalion, Infantry Division, Table of Organization and Equipment No. 7-18E (Washington, D. C.: Department of the Army, 1963). p. 3.

<sup>2</sup>U. S., Army Artillery and Missile School, Policy File (U), Statement No. 13 (Fort Sill: U. S. Army Artillery and Missile School, 1964), p. 1.

<sup>3</sup>U. S., Continental Army Command, World Wide Combat Arms Conference II (U), Vol II (3 vols.; Washington, D. C.: U. S. Continental Army Command, 1962), p. 197.

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only rudimentary transportation networks, as in South Vietnam, the movement of modern forces is reduced to--or less than--that of the guerrillas who are capable of operating without established road systems. This lack of effective off-road mobility was a major contributing factor in the defeat of the French in Indochina.<sup>4</sup> So the problem is the need for highly mobile units which are not bound to the existing roads.

As already mentioned, the artillery must have the following ground mobility capabilities to operate in the tropics:

1. Be able to traverse dense jungles.
2. Be able to traverse mountainous terrain.
3. Be able to cross inland streams--to include swamps and rice paddies.

Of the three ground mobility requirements, the traversing of dense jungles presents the severest problem. A report prepared by the United States Army Combined Arms Combat Development Agency in 1962 stated:

It is doubtful that any ground vehicle will be able to operate in dense jungle. While the vehicle may be able to negotiate the soil conditions in the areas, the matted undergrowth and other obstacles such as trees will make operations difficult if not impossible.<sup>5</sup>

Granted, operations in the dense jungle are extremely difficult, but they are not impossible. A ground mobility test conducted in the jungles of Panama in 1962 resulted in the following conclusion: "Operation SWAMP FOX I substantiates the conclusions drawn as the result of

<sup>4</sup>Advanced Research Projects Agency, Project AGILE (U), Quarterly Report QR-10 (Washington, D. C.: Advanced Research Projects Agency, 1963), p. 48.

<sup>5</sup>U. S., Army Combined Arms Combat Development Agency, Military Requirements for Potential Counter-insurgency Operations (U) (Fort Leavenworth: U. S. Army Combined Arms Combat Development Agency, 1962), p. D-12.

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environmental operation TROPICAL WET<sup>6</sup> that transportation support of military operations in a tropical environment is feasible."<sup>7</sup> Under Project AGILE, vehicles with design characteristics suited for operations along jungle trails and through rice paddies and swamps are presently being tested in Southeast Asia.<sup>8</sup> The results of these tests will not be known until mid-1966.<sup>9</sup> Therefore, the problem is: Which of the present U. S. vehicles, or type vehicles, are best suited for jungle operations?

Operations in the jungle impose greater restrictions on the movement of artillery than operations in other types of terrain.<sup>10</sup> A brief look back to World War II shows how some of the difficulties encountered in jungle operations were overcome. The same problem being considered now was encountered by U. S. Forces in the jungles of the Southwest Pacific.

To increase the mobility of the artillery of the 32nd Infantry Division in New Guinea, the three 105-mm howitzer battalions of the division were converted as follows:

1. One battalion was converted to a horse-pack, 75-mm howitzer battalion.
2. One battalion was converted to a  $\frac{1}{2}$ -ton truck drawn 75-mm howitzer battalion.

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<sup>6</sup>U. S., Army Transportation Board, Report of Environmental Operation TROPICAL WET (Fort Eustis: U. S. Army Transportation Board, 1960), p. 3.

<sup>7</sup>U. S., Army Transportation Board, Report of Environmental Operation SWAMP FOX I (Fort Eustis: U. S. Army Transportation Board, 1962), p. 5.

<sup>8</sup>Project AGILE (U), op. cit., p. 81.

<sup>9</sup>Ibid., p. 52.

<sup>10</sup>U. S., Department of the Army, Field Artillery Tactics, Field Manual 6-20-2 (Washington, D. C.: Department of the Army, 1962), p. 82.

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3. One battalion was converted to a stripped,<sup>11</sup> 105-mm howitzer battalion.

The 41st Infantry Division, also while in New Guinea, converted its artillery in a similar fashion.<sup>12</sup> The Australians experimented with "man powered" carts to transport its disassembled artillery over jungle trails.<sup>13</sup>

Similar examples of the solution to the artillery mobility problem during the fighting in the jungles during World War II can be found, but the solutions all point to the same requirements: the artillery must be light and small. In other words, the artillery, for jungle use, must:

1. Be of such weight and size that it can be towed by a small size vehicle or be capable of being disassembled into small, light weight components which can be carried by small vehicles or animals, or moved in carts or manhandled; or

2. Be mounted in or on a vehicle small enough to traverse the jungle trails.

The traversing of dense jungles with the present U. S. vehicles is extremely difficult, but what type of vehicle is best suited for jungle operations? A series of tests, conducted from 1960 to 1962 in the jungles of Panama, resulted in the following conclusion:

The overwhelming superiority of tracked vehicles over wheeled equipment for use in tropical terrain is not an unexpected

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<sup>11</sup>To lighten the howitzers, all items unnecessary for firing, such as the shields, are removed.

<sup>12</sup>"Observations in Southwest and South Pacific Theaters During the Period 5 April 1943 to 14 Jul 1943." (U. S. Army Ground Forces, Washington, D. C.: 1943), p. 6. (Mimeographed)

<sup>13</sup>"Army Ground Forces Observer's Report, 26 September-23 December 1942" (U. S. Army Ground Forces, Washington, D. C.: 1942), p. 2. (Mimeographed)

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determination, for TROPICAL WET and SWAMP FOX I gave earlier proof of the greater compatibility of the full-tracked vehicles with this environment.<sup>14</sup>

The traversing of mountainous terrain presents a problem but not of the magnitude presented by the jungles. Artillery was used quite successfully in the mountains during World War II and during the Korean conflict.<sup>15</sup> In mountainous terrain--disregarding helicopter lift for the present--the artillery is somewhat road bound or, at least, limited to movement on improved trails. In mountainous terrain, the ability to climb slopes and tow loads up these slopes becomes of prime interest. Most U. S. vehicles, both wheeled and tracked, are designed to climb a longitudinal slope of 60%. The superior tractive ability of the full tracked vehicle over the wheeled vehicle is illustrated in Figure 8 which shows the comparative trafficability for representative type soil conditions. The tractive efficiency shown in the figure is a measure of the "effort available to climb slopes, accelerate the vehicle, tow loads, or perform other forms of useful work."<sup>16</sup> The figure clearly portrays the superiority of tracked vehicles over wheeled vehicles in mountainous terrain.

The requirement to cross inland waterways, swamps, and rice paddies presents a unique problem. The desirable vehicle should have the

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<sup>14</sup>U. S., Army Material Command, Final Report SWAMP FOX II, Vol I (10 vols.; Washington, D. C.: U. S. Army Material Command, 1964), p. 1.

<sup>15</sup>An example of the successful use of artillery in the mountains of Italy during World War II is found in "IV Corps Artillery in Pursuit" (Headquarters, IV Corps Artillery, APO 304, December 1944) (Mimeographed) and an example of artillery use in the mountains of Korea is found in a lecture presented by Lt. Gen. Edward M. Almond, "Conference on Battle Employment of Artillery in Korea" (The Army War College, Carlisle Barracks, Pennsylvania, 1952).

<sup>16</sup>U. S., Army Artillery and Missile School, Study: Requirements for the Development of Field Artillery Weapons for the Period 1965-70 (U) (Fort Sill: U. S. Army Artillery and Missile School, 1962), p. E-8. (Emphasis supplied.)

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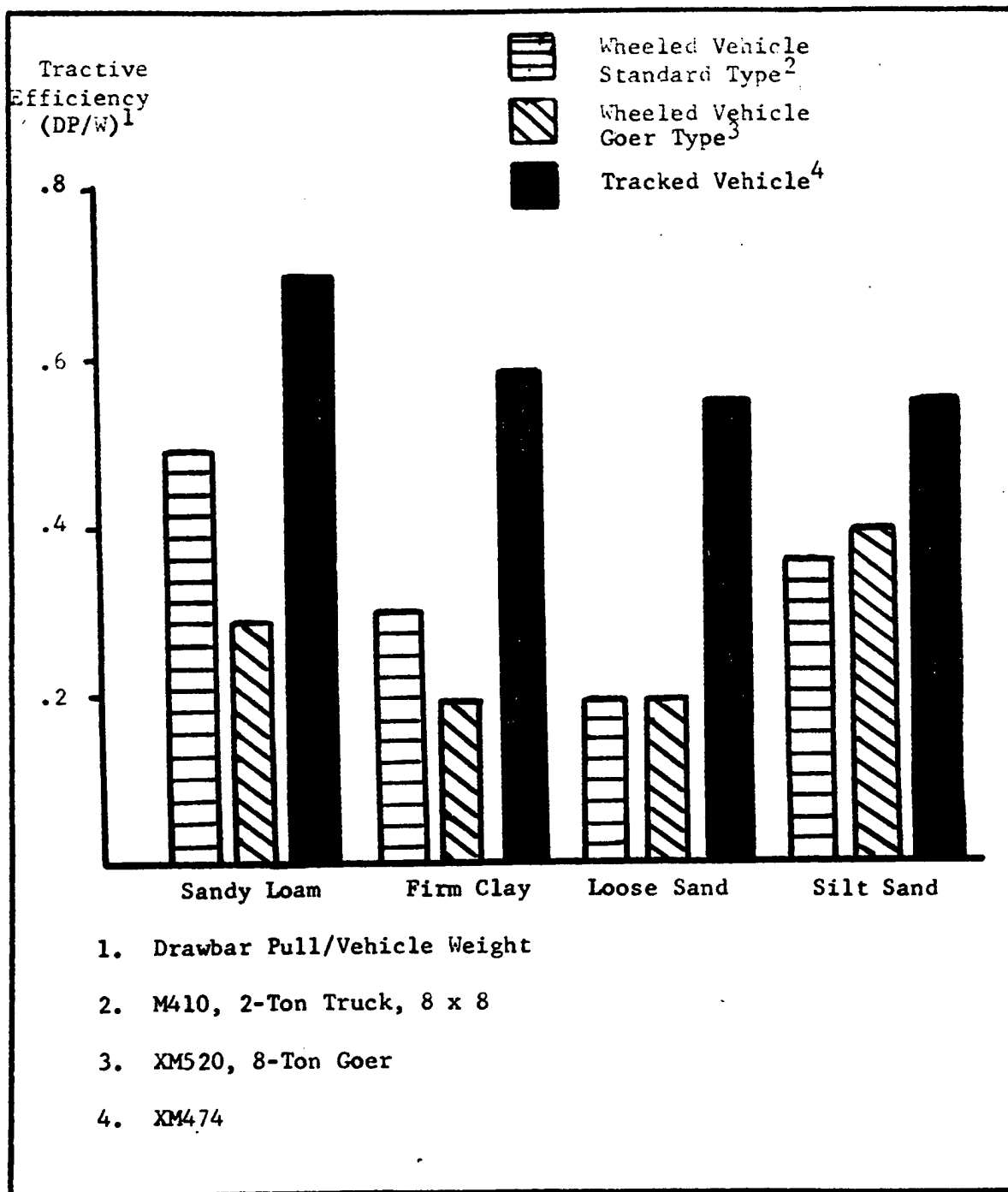


Fig. 8. --The comparative trafficability of wheeled versus tracked vehicles.<sup>17</sup>

<sup>17</sup>Ibid., p. E-9.

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optimum performance characteristics on water as well as on land. As pointed out, the Artillery School prefers to have a vehicle which can swim. This favors the use of a self-propelled weapon. The second preference is for a float capability which then permits the use of the wheeled vehicle. Nevertheless, the vehicle and its weapon must be able to cross streams and travel on land. Hence, an amphibious type vehicle is most desirable.

The ground mobility of a field artillery weapon depends on many factors. Several of these which have been discussed or implied are speed, slope climbing ability, obstacle and water crossing ability, and maneuverability. These result from the weight, power, and tractive efficiency of the vehicle.

"Low weight enhances the mobility of field artillery weapons."<sup>18</sup> Weight, as such, does not have a significant effect on ground mobility since a heavier vehicle, properly powered will be able to cross terrain similar to the lighter vehicle. Gross weight will affect the speed of movement, and will have a bearing on the bridge and water crossing ability of the vehicle.<sup>19</sup> It should be remembered that the weight of the prime mover must be added to the weight of the weapon itself to arrive at the weight for the weapon system.

In 1962, thirty-six types of wheeled and tracked vehicles were given a comparative mobility test at Fort Eustis, Virginia. The test covered sixteen types of soil and terrain conditions which, "to some degree may be considered [a] representative yardstick of mobility."<sup>20</sup> The

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<sup>18</sup>Ibid., p. E-5.

<sup>19</sup>Ibid., pp. E-5 - E-6. (Emphasis supplied)

<sup>20</sup>U. S., Army Ordnance Tank-Automotive Command, Project WHEEL-TRACK, Comparative Operational Mobility Evaluation Summary Report (Center Line, Michigan: U. S. Ordnance Tank-Automotive Command, 1962), p. 10.

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conclusions drawn were: "Tracked vehicles are generally superior to wheeled vehicles in the difficult off-road situations requiring mobility."<sup>21</sup>

Based on the foregoing discussion, the desired prime mover, in order of preference, is:

1. A full-tracked vehicle which is light-weight, small, can swim, and has good maneuverability or trafficability.
2. A wheeled vehicle which is light, small, floatable, and has good maneuverability and trafficability.

The desired characteristics of the artillery weapon, as they relate to ground mobility, in order of preference, are:

1. That the weapon be mounted on the full-tracked vehicle mentioned above.
2. That the weapon be small and light-weight so it can be towed by a small vehicle (either full-tracked or wheeled) and be capable of being disassembled into light-weight components.
3. That the weapon be small and light-weight for towing by a small vehicle (either full-tracked or wheeled), but not capable of easy disassembly.

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<sup>21</sup>U. S., Army Transportation Board, Army Tank-Automotive Center, and Army Engineering Agency, Project WHEELTRACK I, A Joint Comparative Operational Mobility Evaluation, Vol I (3 vols.; Fort Eustis: U. S. Army Transportation Board, 1963), p. 7.

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Air Mobility Requirements<sup>22</sup>

In counter guerrilla warfare in the difficult terrain found in the tropics, the ability to move artillery by helicopter is a necessity. In a report on counter guerrilla warfare in 1962, the United States Army Command and General Staff College stated: "Because of the difficulty of the terrain and the absence of adequate lines of communication, major dependence must be placed on air mobility."<sup>23</sup> Today, in South Vietnam, the artillery, especially in mountainous areas, is frequently moved by helicopter.<sup>24</sup> The movement of artillery by helicopter affords the opportunity to move into position rapidly for the normal surprise attack. The obvious advantages of moving artillery by helicopter are speed and the ability to negotiate terrain which is difficult or impossible to traverse by ground vehicles.

The lift capabilities of the U. S. helicopters expected to be assigned to tactical army units for the foreseeable future are shown as follows: Figure 9 for the CH-34A, Figure 10 for the CH-47A, and Figure 11 for the UH-1D.<sup>25</sup> Since the most important variables affecting lift

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<sup>22</sup>The discussion of the air mobility requirement is limited to the use of the helicopter because the lift capability of the helicopter is much smaller than that of most fixed wing aircraft. Any load which a helicopter can transport can be lifted and transported by at least one of the fixed wing aircraft of the United States. Also, the helicopter can place the weapon in the desired position area but, if the weapon is transported by a fixed wing aircraft, the weapon would have to be dropped by parachute, which is not an accurate method of delivery. Miss delivery, especially in jungle operations where the position area is apt to be small, creates many problems.

<sup>23</sup>U. S., Army Command and General Staff College, A Detailed Concept for Employment of US Army Combat Units in Military Operations Against Irregular Forces (U) (Fort Leavenworth: U. S. Army Command and General Staff College, 1962), p. A-15. (Emphasis supplied)

<sup>24</sup>U. S., Continental Army Command Counterinsurgency, Lessons Learned (U), Continental Army Command Pamphlet 515-4 (Fort Monroe: U. S. Continental Army Command, 1962), p. 199.

<sup>25</sup>Computations for the development of Figures 9, 10, and 11 are contained in Appendix II.

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[ ] 92.5 kilometers radius

( ) 55.0 kilometers radius

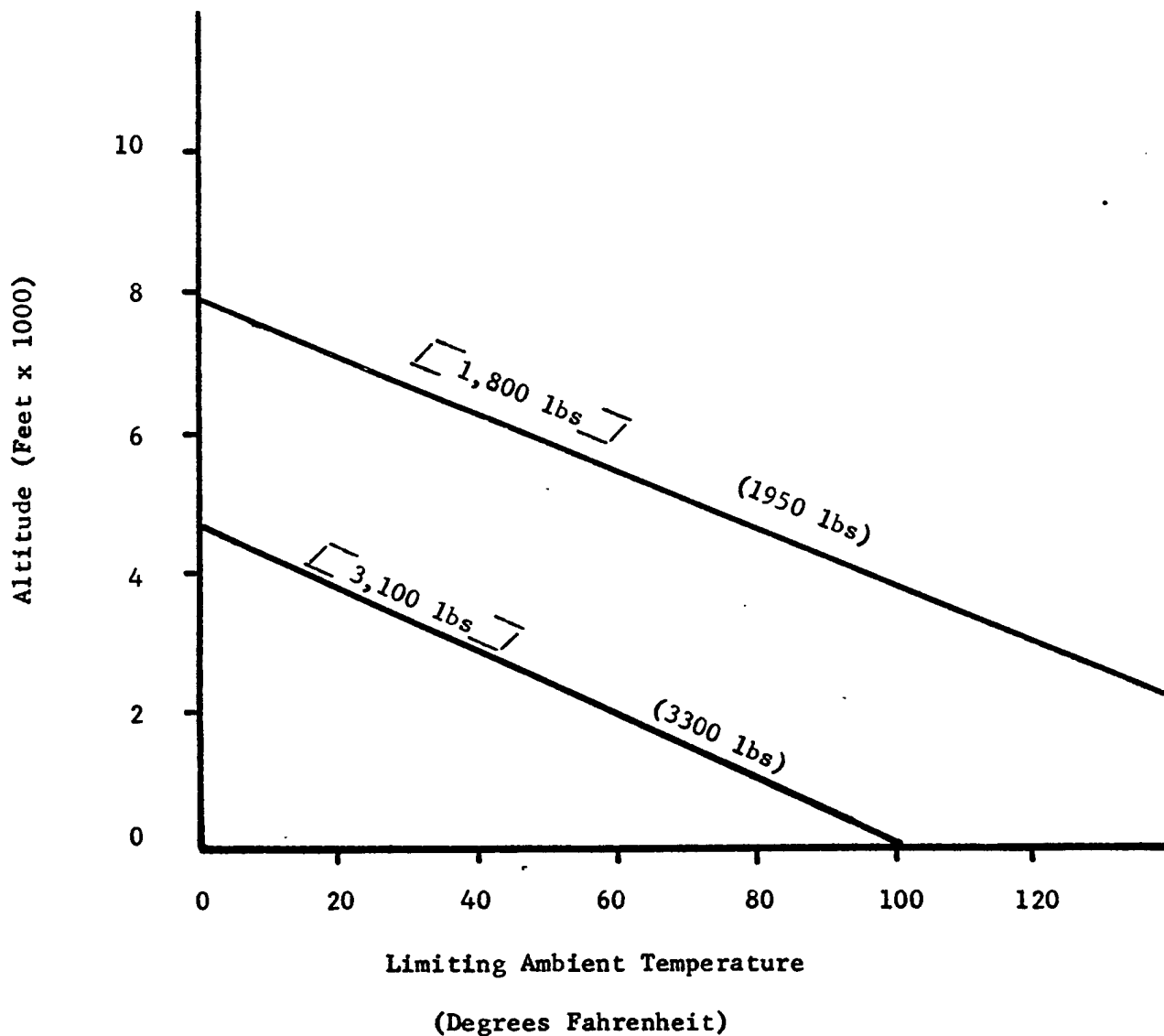


Fig. 9.--Payload of CH-34A helicopter versus altitude and limiting ambient temperature.

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[ ] 92.5 kilometer radius

( ) 55.0 kilometer radius

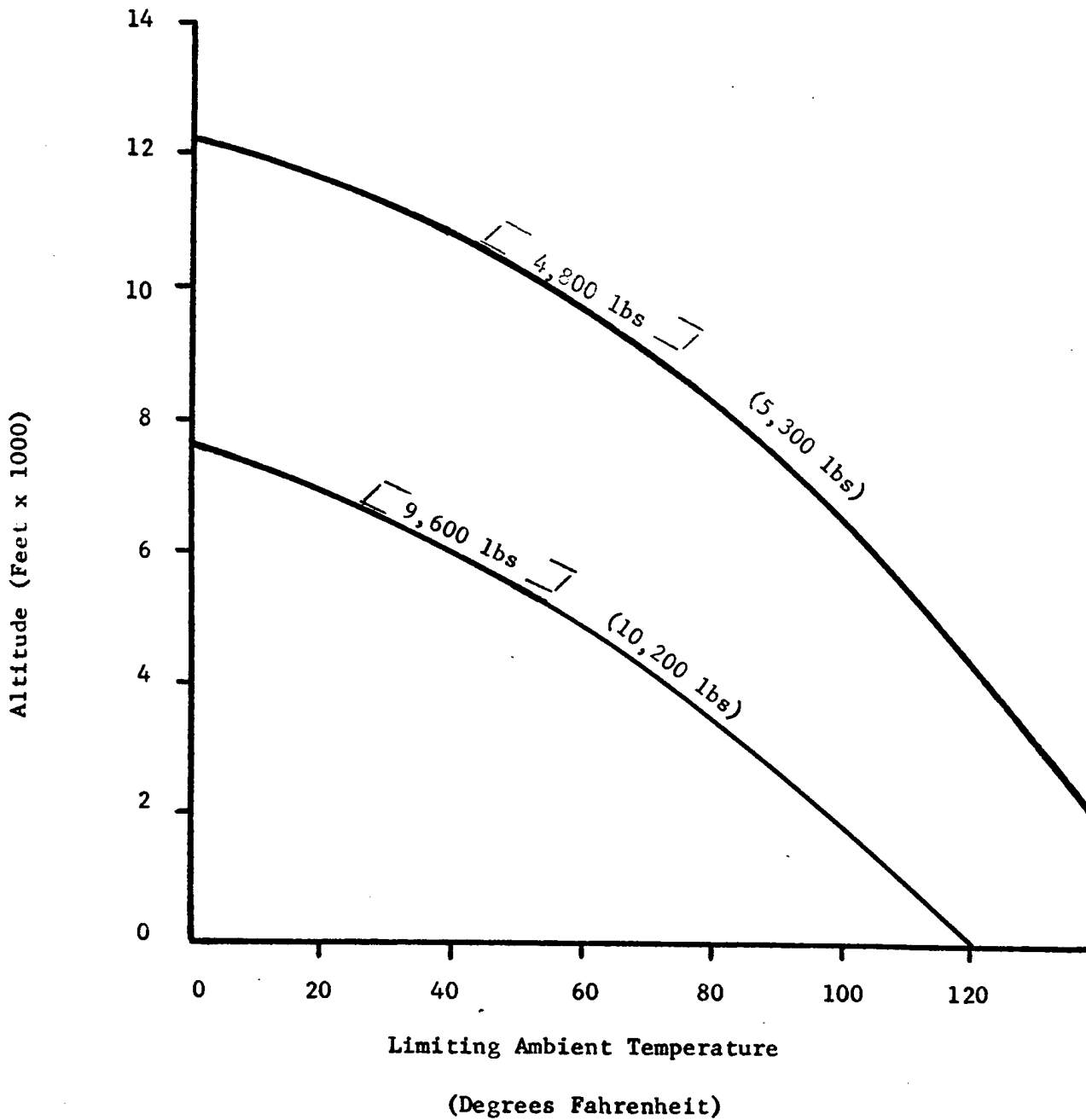


Fig. 10.--Payload of the CH-47A helicopter versus altitude and limiting ambient temperature.

[ ] 92.5 kilometer radius

( ) 55.0 kilometer radius

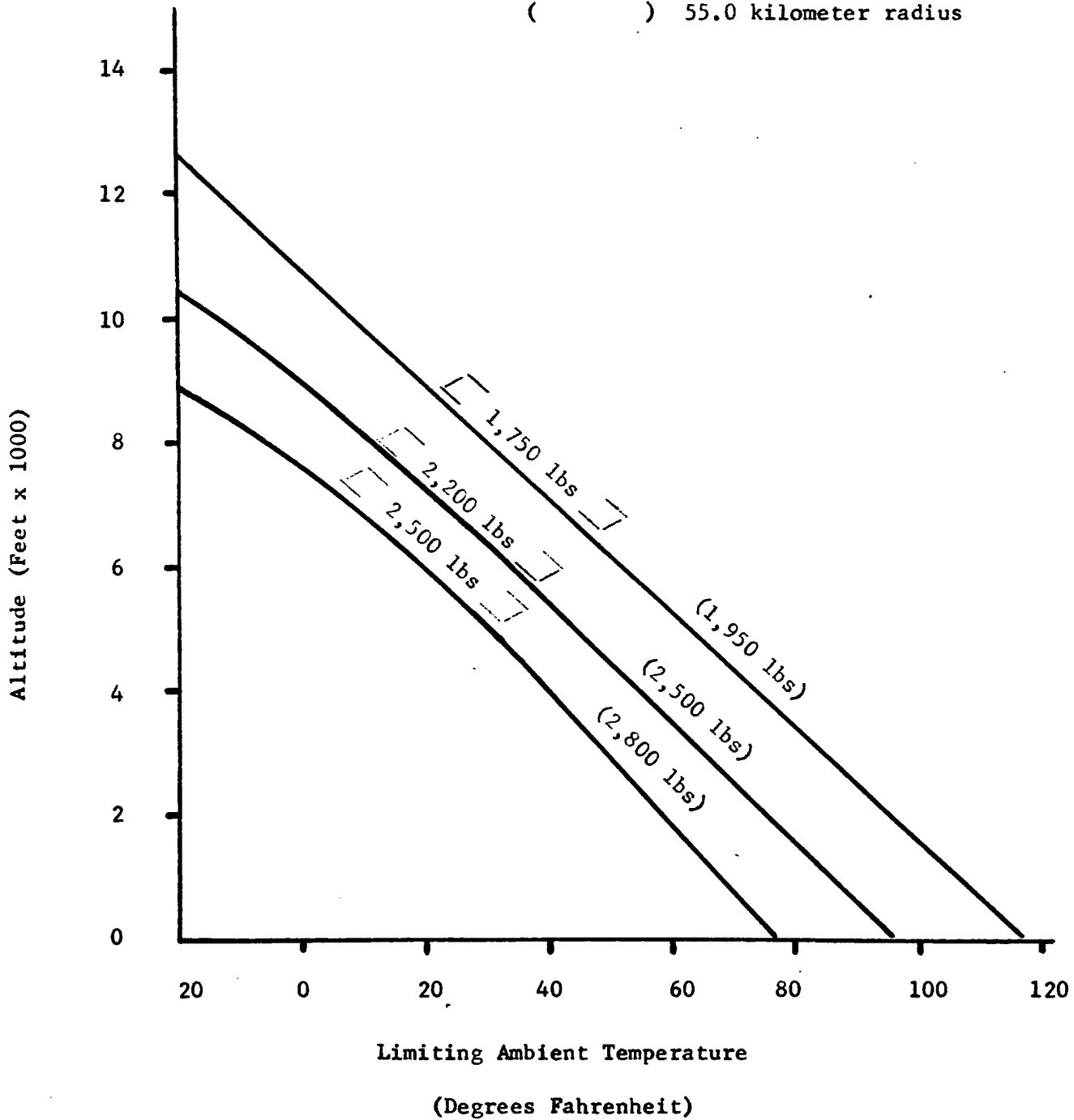


Fig. 11.--Payload of UH-1D helicopter versus altitude and limiting ambient temperature.

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capability are altitude, temperature, and range, Figures 9, 10, and 11 relate lift capability to these variables.

The two variables of altitude and temperature are often combined together into what is known as "density altitude," it being altitude corrected by the ambient temperature, the outside temperature at that altitude. Any increase in temperature or altitude will result in a higher density altitude; and, as the density altitude increases, the lift capability of the helicopter decreases. The range of the mission has a bearing on the lift capability of the helicopter because of the weight of the fuel involved. Naturally, the longer the mission, the greater is amount of fuel required and hence, the lower the useful load capacity.

The use of Figures 9, 10 and 11 can be illustrated by the following example. Assume a UH-1D helicopter (Figure 11) is to move an artillery weapon, which weighs 1,750 pounds, to a position which is ninety-two kilometers away. If the altitude of the flight were at 4,000 feet, the limiting ambient temperature would be about seventy-three degrees Fahrenheit. In other words, if the temperature be less than seventy-three degrees Fahrenheit, the load of 1,750 pounds can be carried; if the temperature were about seventy-three degrees Fahrenheit the movement can not be accomplished. Approaching the problem in another way, if the ambient temperature be 100 degrees Fahrenheit, to carry a load of 1,750 pounds, the UH-1D has to fly at an altitude less than 1,500 feet.

Figures 9, 10, and 11 are plotted for mission radii of 92.5 and 55 kilometers. A report prepared by the U. S. Army Artillery and Missile School states the determination of likely mission radii is somewhat arbitrary. The report goes on to say, "Missions in support of infantry battalions might normally be expected to be on the order of less than 50 to 60 kilometers in radius"...while "missions in support of counter-

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guerrilla operations in areas such as Southeast Asia may require a much greater radius of action, perhaps 100 to 150 kilometers."<sup>26</sup> Because of this statement, and the availability of data, the two radii of action were arbitrarily selected as 92.5 and 55 kilometers.

Table 3 shows other relevant characteristics of the three helicopters.

TABLE 3  
EXTERNAL LOAD AND INTERIOR CARGO SIZE CAPABILITIES

	CH-34A <sup>a</sup>	CH-47A <sup>b</sup>	UH-1D <sup>c</sup>
Max external payload (lbs)	5,000	16,000	4,100
Cargo door width (in)	48	90	N/A
Cargo door height (in)	53	78	
Cargo compartment width (in)	70	90	
Cargo compartment height (in)	59	78	N/A
Cargo compartment length (in)	163	362	

<sup>a</sup>U. S., Department of the Army, Operator's and Crew Members' Instructions, Army Model H-34A, H-34C Helicopters, Technical Manual 55-1520-202-10 (Washington, D. C.: Department of the Army, 1962), pp. 124, 182, and 206.

<sup>b</sup>U. S., Department of the Army, Operator's Manual, Army Model HC-1B Helicopter, Technical Manual 55-1520-209-10 (Washington, D. C.: Department of the Army, 1963), Chapter 12, pp. 4-13 and 4-20.

<sup>c</sup>U. S., Department of the Army, Operator's and Crew Members' Maintenance Manual, Army Model UH-1D Helicopter (Washington, D. C.: Department of the Army, 1963), Chapter 2, p. 2-3.

<sup>26</sup>Study: Requirements for the Development of Field Artillery Weapons for the Period 1965-70 (U), op. cit., p. E-23.

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To determine the desirable characteristics of the artillery weapon for movement by helicopter, data for an operation in South Vietnam are used. Table 4 shows the mean daily temperatures for South Vietnam as determined by a National Intelligence Summary.

TABLE 4  
MEAN DAILY TEMPERATURES, SOUTH VIETNAM<sup>a</sup>

Area		Temperature (°F)	Altitude (ft)
Coastlands	Maximum	96	53
	Minimum	63	52
Highlands	Maximum	92	1759
		80	4921
		50	4921

<sup>a</sup>U. S., Central Intelligence Agency, National Intelligence Summary, South Vietnam, Section 23: Weather and Climate (U) (Washington, D. C.: U. S. Central Intelligence Agency, 1959), p. 23-37 and Figures 23-34.

Two cases are considered for the determination of the desirable characteristics of the artillery weapon for movement by helicopter: operations in the jungles and operations in the mountains.

First, jungle operations are considered. Assuming a CH-47A (Figure 10) cruises at 2,000 feet, it is able to lift a 4,800 pound load on a mission radius of 92.5 kilometers if the ambient temperature is 140 degrees Fahrenheit or below, or a 5,300 pound load on a mission radius of 55 kilometers with the same temperature limitation. Likewise, it can lift 9,600 pounds on a mission radius of 92.5 kilometers or a 10,200

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pound load on a 55 kilometer mission if the ambient temperature is 98 degrees Fahrenheit or below. From Table 4, it is seen that the maximum mean daily temperature on the lowlands is 96 degrees Fahrenheit. Therefore the loads mentioned could be moved the distance stated by the CH-47A. Table 5 is a summary of the limiting weights and temperatures

TABLE 5  
HELICOPTER CAPABILITIES IN JUNGLE OPERATIONS

	Altitude (ft)	Range (km)	Load (lbs)	Limiting Temperature (°F)
CH-34A	2000	92.5	1800	140
		55.0	1950	
		92.5	3100	59
		55.0	3300	
CH-47A	2000	92.5	4800	140
		55.0	5300	
		92.5	9600	98
		55.0	10200	
UH-1D	2000	92.5	1750	95
		55.0	1950	
		92.5	2200	73
		55.0	2500	

for the three helicopters under consideration in jungle operations conducted under the conditions assumed.

Table 5 shows the helicopter capabilities in jungle operations. The table shows that for operations in a jungle environment, where the mean daily temperature is 95 degrees Fahrenheit, loads from 1,750 pounds (UH-1D) to 9,600 pounds (CH-47A) can be moved a distance of 92.5 kilometers. These loads are well within the maximum external payloads shown

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in Table 3. This weight range -- from 1,750 pounds to 9,600 pounds -- is of importance in the next chapter when the weights of artillery weapons are considered.

Next, mountain operations are considered. Assuming the CH-47A cruises at 5,000 feet, it is able to lift a 4,800 pound load on a mission radius of 92.5 kilometers if the ambient temperature is 115 degrees Fahrenheit or below or a 5,300 pound load on a mission radius of 55 kilometers with the same temperature limitation (Figure 10). It can lift 9,600 pounds on a mission radius of 92.5 kilometers or a 10,200 pound load on a 55 kilometer mission if the ambient temperature is 58 degrees Fahrenheit or below. From Table 4, the maximum mean daily temperature at the altitude of 4,921 feet is seen to be 80 degrees Fahrenheit. Therefore, only a load of slightly less than 9,600 pounds can be moved 92.5 kilometers. (The exact load can be determined from Technical Manual 55-1520-210-10.)

Table 6 is a summary of the limiting ambient temperatures for the three helicopters under consideration in mountain operations under the assumed conditions. In a mountainous area, where the maximum mean daily temperature is 92 degrees Fahrenheit, Table 6 indicates that only the CH-47A is capable of moving a relatively heavy load. The CH-47A can move approximately 5,000 pounds the distances under consideration. The other two helicopters have limited use in mountain operations. This load of 5,000 pounds is of importance in the next chapter when the weight of artillery weapons are considered.

The CH-47A has a relatively large cargo compartment. Movement to areas, which are cleared of obstacles and on which a helicopter can land, is facilitated if the weapon is carried inside the helicopter. This eliminates the slinging of the external load and possible damage to

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TABLE 6

## HELICOPTER CAPABILITIES IN MOUNTAIN OPERATIONS

	Altitude (ft)	Range (km)	Load (lbs)	Limiting Temperature (°F)
CH-34A		92.5	1800	70
	5000	55.0	1950	
		92.5	3100	-6
		55.0	3300	
CH-47A		92.5	4800	115
	5000	55.0	5300	
		92.5	9600	58
		55.0	10200	
UH-1D	5000	92.5	1750	62
		55.0	1950	
		92.5	2200	44
		55.0	2500	

the weapon by dropping or hitting against objects in the loading or landing area. The artillery weapon should be less than 90 inches in width, 78 inches in height, and 362 inches in length to fit internally into the CH-47A.

The movement by helicopter is not a panacea for moving artillery in difficult terrain. As stated earlier, the guerrilla normally attacks during hours of darkness or reduced visibility; and, hence, if the helicopter is to be used as the prime mover, the mobility of the artillery

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is reduced to zero during conditions of low visibility or heavy rains. The artillery weapon must be capable of being moved by some means other than just the helicopter.

Based on the discussion in this section, to be moved by helicopter, artillery should have the following characteristics:

1. Depending on the helicopter available, the weapon, or its components, should have a weight less than the following:
  - a. Approximately 1,700 pounds if it is to be transported by the CH-34A.
  - b. Approximately 8,000 pounds if it is to be transported by the CH-47A.
  - c. Approximately 1,200 pounds if it is to be transported by the UH-1D.
2. Not to exceed 90 inches in width, 78 inches in height, and 362 inches in length.

#### Summary

In this chapter ground and air mobility requirements are considered. Based on the discussion, the artillery weapon should have the following characteristics:

1. Be mounted on a full-tracked vehicle which is light weight, small, can swim, and has good maneuverability or trafficability; or be small and light weight so it can be towed by a small, light weight vehicle (either full-tracked or wheeled) and, depending on the weight of the weapon, be capable of being disassembled into light weight components.
2. Preferably, not exceed 1,700 pounds in weight so it can be moved by our cargo helicopters but, as a minimum, weigh less than 8,000 pounds so it can be moved by the CH-47A; or can be disassembled into

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components which weigh no more than 1,200 pounds to insure the components can be carried by any of the three helicopters but, at least, weigh less than 1,700 pounds to enable the components to be carried by either of the two cargo helicopters.

3. Not exceed the dimensions stated above so the weapon can be carried internally by the CH-47A.

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## CHAPTER V

COMPARISON OF DESIRABLE CHARACTERISTICS  
AND WEAPONS

## General

This chapter is devoted to a comparison of likely field artillery weapons and the desired characteristics and capabilities determined in the previous two chapters. This comparison is made to determine which weapon or weapons best meets the desired characteristics or capabilities.

The following is a summary of the desired characteristics or capabilities, as determined in Chapters III and IV, which an artillery weapon should have to effectively support counter guerrilla warfare:

1. Be accurate.
2. Be able to fire a variety of fuzes.
3. Be able to fire a variety of shells.
4. Be able to fire high angle fire.
5. Be able to fire direct fire.
6. Be able to traverse through a complete circle.
7. Be emplaced rapidly.
8. Have a long range.
9. Be able to fire indirect fire at short ranges.
10. Have a high rate of fire.
11. Be small (less than 90 inches in width, 78 inches in height,

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and 362 inches in length) and light weight; or

13. Be capable of being disassembled into light weight components.

14. Be able to be transported, either complete or in components, by the cargo helicopters.

15. Have a swim capability.

For the comparison, the following weapons are considered:<sup>1</sup>

1. 75-mm pack howitzer.
2. 105-mm howitzer, M101A1, towed.
3. 105-mm howitzer, M102, towed.
4. 105-mm howitzer, M104, self-propelled.

It should be noted the above list includes the 75-mm pack howitzer, which is contained in only one Table of Organization and Equipment (6-285E) and then only as a discretionary weapon for the field artillery howitzer battalion of a separate airborne brigade when light equipment is required<sup>2</sup>; the 105-mm howitzer, which is organic to the infantry division; the 105-mm howitzer, M102, which is organic to the airborne division; and the M104, which is the self-propelled version of the M102.

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<sup>1</sup>The larger caliber weapons can be used in a general support role but are unsuitable for a direct support role in counter guerrilla warfare because of their weight and size. The 155-mm howitzer, M114A1, for instance, is 7,970 pounds heavier, 40 inches longer, 12 inches wider and 11 inches higher than the 105-mm howitzer, M101A1. Also the larger caliber weapons require a heavier and larger prime mover than that required for the weapons under consideration. (U. S. Department of the Army, Field Artillery Cannon Gunnery, Field Manual 6-40 /Washington, D. C.: Department of the Army, 1960/, Table I).

<sup>2</sup>U. S., Department of the Army, Separate Airborne Brigade Field Artillery Howitzer Battalion, 105MM, Towed, Table of Organization and Equipment No. 6-285E (Draft) (Washington, D. C.: Department of the Army, n. d.), p. 3.

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Table 7 contains, in chart form, pertinent characteristics and capabilities of these weapons.

TABLE 7  
CHARACTERISTICS AND CAPABILITIES OF  
FIELD ARTILLERY WEAPONS CONSIDERED<sup>a</sup>

Caliber and Model	Traveling			
	Weight (pounds)	Width (inches)	Height (inches)	Length (inches)
75-mm Pack Howitzer M116	1,440	50	31	126
105-mm Howitzer M101A1 (Towed)	4,980	84	60	236
105-mm Howitzer M102 (Towed)	3,060	71	60	258
105-mm Howitzer M104 (Self- Propelled) <sup>b</sup>	7,500 <sup>c</sup>	63	78	145

<sup>a</sup>Except where noted by other footnotes, the contents of Table 7 were taken from U. S., Department of the Army, Field Artillery Cannon Gunnery, Field Manual 6-40 (Washington, D. C.: Department of the Army, 1960), Table I.

<sup>b</sup>U. S., Office of the Chief of Ordnance, Development of 105-mm Self-Propelled Light Howitzer, XM104 (U), Technical Information Report 3-2-1J3 (Washington, D. C.: Office of the Chief of Ordnance, 1961), pp. 4-5.

<sup>c</sup>Can be reduced to 6,000 pounds, without disassembling, for air movement.

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TABLE 7 -- Continued

Caliber and Model	Maximum Range (meters)	Minimum Range High Angle (meters)	Traverse Limits (mils)
75-mm Pack Howitzer M116	8,800	-	53 (3 degrees) right and left of center
105-mm Howitzer M101A1 (Towed)	11,000	1,600	409 (23 degrees) right and 400 (22 degrees) left of center
105-mm Howitzer M102 (Towed)	11,500	2,300 <sup>e</sup>	6,400 (360 degrees)
105-mm Howitzer M104 (Self- Propelled)	14,800 <sup>d</sup> 11,500 14,800	1,100 <sup>d,f</sup> 2,300 <sup>e</sup> 1,100 <sup>d,f</sup>	398 (22 degrees) right and left of center

<sup>d</sup>Extended Range Ammunition.

<sup>e</sup>U. S., Department of the Army, Firing Tables Cannon, 105mm Howitzer: M103 on Howitzer, Light, Self-Propelled: 105mm, M108 Firing Cartridge, HE, M1; Cartridge, Gas, Persistent, H, M60; Cartridge, Gas, Persistent, HD, M60; Cartridge, Gas, Nonpersistent, GB, M360; Cartridge, Smoke, WP, M60; Cartridge, Smoke, BE, M84 and M84B1 (HC and Colored); Cartridge, Illuminating, M314 Mods; Cartridge, HEP-T, M327; Cartridge, HEP, M327 (U), Firing Tables 105-AS-1 (Washington, D. C.: Department of the Army, 1963), p. 24.

<sup>f</sup>U. S., Office of the Chief of Ordnance, Development of 105-mm High Explosive Shell, M442 (T388) (U), Technical Information Report 6-9-7A12 (1) (Washington, D. C.: Office of the Chief of Ordnance, 1961), p. 10.

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TABLE 7 -- Continued

Caliber and Model	Elevation Limits (mils)	Maximum Rate Of Fire (rounds per minute for first three minutes)	Sustained Rate Of Fire (rounds per minute)
75-mm Pack Howitzer M116	-89 to $\nearrow$ 800 (-5 to 45 degrees)	8	2 $\frac{1}{2}$ <sup>g</sup>
105-mm Howitzer M101A1 (Towed)	-89 to $\nearrow$ 1,156 (-5 to $\nearrow$ 65 degrees)	10	1 $\frac{1}{2}$ <sup>g</sup>
105-mm Howitzer M102 (Towed)	-89 to $\nearrow$ 1,300 (-5 to $\nearrow$ 73 degrees)	10	3 <sup>h</sup>
105-mm Howitzer M104 (Self- Propelled)	-89 to $\nearrow$ 1,342 (- 5 to $\nearrow$ 75 degrees)	10	3 <sup>h</sup>

<sup>g</sup>"Weapons," Artillery Trends, July 1963, p. 4.

<sup>h</sup>U. S., Army Material Command, Development of 105mm Howitzer Cannon, XM103 (U), Technical Information Report 1-1-2J6 (1) (Washington, D. C.: U. S. Army Material Command, 1963), p. 9.

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TABLE 7 -- Continued

Caliber and Model	Prime Mover	Time to Emplace (minutes)	Smoke and Illuminating Shells	Water Crossing Capability
75-mm Pack Howitzer M116	Hel mule-pack $\frac{1}{2}$ -ton	7	Smoke <sup>i</sup> only	Floatable <sup>j</sup>
105-mm Howitzer M101A1 (Towed)	Hel $2\frac{1}{2}$ -ton	3	Both <sup>k</sup>	Floatable <sup>j</sup>
105-mm Howitzer M102 (Towed)	Hel $3\frac{3}{4}$ -ton	4	Both <sup>k</sup>	Floatable <sup>j</sup>
105-mm Howitzer M104 (Self-Propelled)	SP	5	Both	Amphibious

<sup>i</sup>U. S., Department of the Army, Ammunition for Antiaircraft, Tank, Antitank, and Field Artillery Weapons, Technical Manual 9-1300-203 (Washington, D. C.: Department of the Army, 1960), p. 41.

<sup>j</sup>"Weapons," loc. cit.

<sup>k</sup>Field Artillery Cannon Gunnery, op. cit., Table II.

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TABLE 7 -- Continued

Caliber and Model	Ground Clearance (inches)	Weight of Projectile (pounds)	Probable Error at Maximum Range a. Range b. Deflection (meters)	Fuzes
75-mm Pack Howitzer M116	10 <sup>1</sup>	14	a. 32 <sup>m</sup> b. 7 <sup>m</sup>	MTSQ, VT, <sup>t</sup> PD, D, CP
105-mm Howitzer M101A1 (Towed)	14 <sup>s</sup>	33	a. 21 <sup>n</sup> b. 9 <sup>n</sup>	Same <sup>u</sup>
105-mm Howitzer M102 (Towed)	13 <sup>o</sup>	33	a. 18 <sup>p</sup> b. 3 <sup>p</sup>	Same <sup>v</sup>
		28½ <sup>q</sup>	a. 28 <sup>r</sup> b. 9 <sup>r</sup>	PD only <sup>v</sup>
105-mm Howitzer M104 (Self-Propelled)	13	33	a. 18 <sup>p</sup> b. 3 <sup>p</sup>	MTSQ, VT, <sup>u</sup> PD, D, CP
		28½ <sup>q</sup>	a. 28 <sup>r</sup> b. 9 <sup>r</sup>	PD only <sup>v</sup>

<sup>1</sup>U. S., Department of the Army, 75-mm Pack Howitzer M1A1 and Carriage M8, Technical Manual 9-319 (Washington, D. C.: Department of the Army, 1948), p. 11.

<sup>m</sup>U. S., Department of the Army, Firing Tables: Howitzer, 75-MM; M1, M1A1, M2 and M3 Firing Shell, HE, M48; Shell, HE, M41A1; Shell, HE, A.T., M66; Shell, Chemical, M64, Firing Tables 75-I-4 (Washington, D. C.: Department of the Army, 1944), p. 80.

<sup>n</sup>U. S., Department of the Army, Firing Table: Cannon, 105mm Howitzer, M2A1, M2A2 and M49 Firing Cartridge, HE, M1; Cartridge, Gas, Persistent, H. M60; Cartridge, Gas, Persistent, HD, M60; Cartridge, Gas, Nonpersistent, GB, M360; Cartridge, Smoke, WP, M60; Cartridge, Smoke, BE, M84 and M84B1 (HC and Colored), Firing Tables 105-H-6 (Washington, D. C.: Department of the Army, 1961), p. 198.

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<sup>o</sup>U. S., Office of the Chief of Ordnance, Development of 105-MM Towed Light Howitzer, XM102 (U), Technical Information Report 4-1-1J1 (Washington, D. C.: Office of the Chief of Ordnance, 1961), p.4.

<sup>p</sup>Firing Tables Cannon, 105mm Howitzer: M103 on Howitzer, Light, Self-Propelled: 105mm, M108 Firing Cartridge, HE, M1; Cartridge, Gas, Persistent, H, M60; Cartridge, Gas, Persistent, HD, M60; Cartridge, Gas, Nonpersistent, GB, M360; Cartridge, Smoke, WP, M60; Cartridge, Smoke, BE, M84 and M84B1 (HC and Colored); Cartridge, Illuminating, M314 Mods; Cartridge, HEP-T, M327; Cartridge, HEP, M327 (U), op. cit., p. 222.

<sup>q</sup>Extended Range Ammunition.

<sup>r</sup>Development of 105-mm High Explosive Shell, M442 (T388) (U), op. cit., p. 10.

<sup>s</sup>U. S., Department of the Army, 105-MM Howitzer M2A1, Carriages M2A1 and M2A2, and Combat Vehicle Mounts M4 and M4A1, Technical Manual 9-325 (Washington, D. C.: Department of the Army, 1948), p. 18.

<sup>t</sup>Ammunition for Anti-aircraft, Tank, Antitank, and Field Artillery Weapons, op. cit., p. 39.

<sup>u</sup>Ibid., p. 67.

<sup>v</sup>U. S., Army Artillery Board, Service Test, Letter Report for Cartridge, 105-mm, HE, XM482, DA Project No. 5W04-03-026, USATECOM Project No. 2-3-0030-02, USAARTYBD Project No. FA 2359-1 (U) (Fort Sill: U. S., Army Artillery Board, 1964), Inclosure 2, p. 2.

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## 75-mm Pack Howitzer (Figure 12)

To many artillerymen, the 75-mm pack howitzer is the ideal weapon for counter guerrilla warfare. As already stated, the pack howitzer was used in the jungles of the Pacific Area during World War II to replace the bigger and heavier 105-mm howitzer. How does it compare with the list of desirable characteristics?

Of the weapons under consideration it is the least accurate. At maximum range, it has a thirty-two meter probable error in range and a seven meter probable error in deflection. It should be understood that this is the accuracy of the weapon alone. It does not include weather effects or troop training status, which can also reduce the accuracy. It can fire a variety of fuzes, including the variable time, proximity fuze. Considering the characteristics of firing various type shells, one disadvantage of the pack howitzer results from having only a high explosive and white phosphorous shells made for the weapon. Therefore, it has no illuminating capability. Another disadvantage is its inability to fire high angle fire, which is considered necessary for close-in indirect fire as well as to clear position area masks. Its elevation limit is only 800 mils (forty-five degrees), which is approximately the lower limit of high angle fire. The weapon can fire high angle fire if emplaced on an inclined plane,<sup>3</sup> but such a slope is not always available and, therefore, this capability cannot be relied upon. It can fire direct fire (zero mils elevation), as can all the other weapons under consideration. The traverse limits of the weapon are fifty-three mils (three degrees) right and left of center or a total of only 106 mils (six degrees). This limitation is

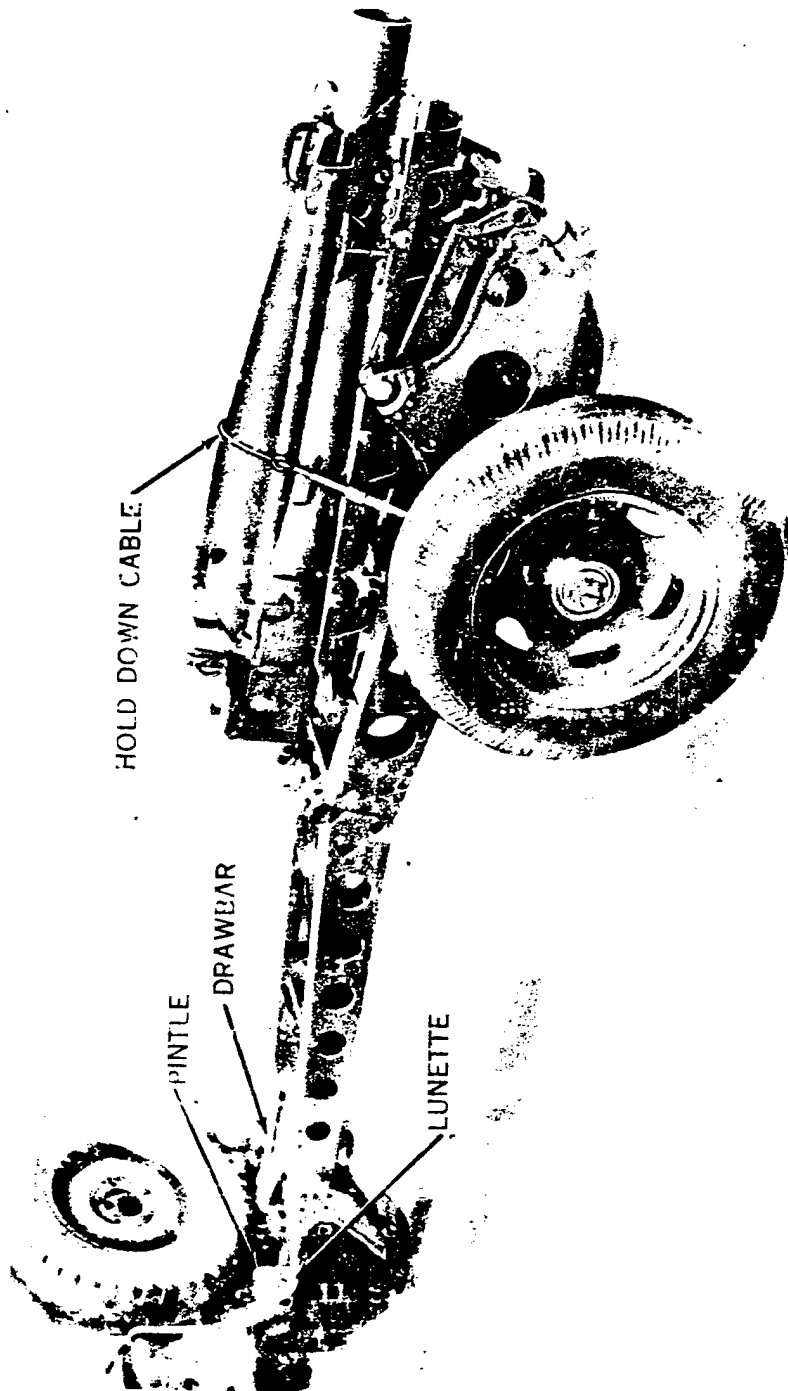
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<sup>3</sup>The firing table is tabulated for elevations in excess of 800 mils to permit such firing.

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Fig. 2.1-inch pack howitzer (AJA)

4U. S., Department of the Army, 75-mm pack howitzer, M8, Technical Manual 11-319 (Washington, D. C.: Department of the Army, 1960), p. 6.

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not as detrimental as it first seems, since the trail can be shifted easily and rapidly because of the light weight and small size of the howitzer. To aid in shifting the trail, a trail trench is dug "with a radius equal to the distance from the axle of the piece to the trail spade," which forms a circle around the howitzer.<sup>5</sup> Hence, the howitzer can be swung around rapidly to fire in a complete circle. It takes a relatively long time, seven minutes, to prepare the weapon for firing from the traveling position.<sup>6</sup> Seven minutes is required for emplacement because the weapon is almost completely disassembled from the traveling configuration and reassembled for the firing configuration. The howitzer has a range of only 8,800 meters and, as was mentioned, for all practical purposes it has no high angle capability and, therefore, has no minimum range for indirect fire worth considering.<sup>7</sup> The howitzer can be fired quite rapidly: eight rounds per minute for the first three minutes and two-and-a-half rounds per minute thereafter. The howitzer can be towed by a one-quarter ton truck or moved complete by the cargo helicopters. It can also be broken down into components which can be carried by eight animals. None of the loads weighs more than 250 pounds.<sup>8</sup>

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<sup>5</sup>U. S., Department of the Army, 75-MM Pack Howitzer M1A1, Field Manual 6-78 (Washington, D. C.: Department of the Army, 1963), p. 54.

<sup>6</sup>The times for emplacement contained in Table 7 are approximate. The weather, terrain, and status of training will have a bearing on the time.

<sup>7</sup>The weapon does have a minimum range for indirect fire but it is difficult to say at what elevation direct fire stops and indirect fire starts, and, because of the expected position area mask, the minimum range desired is the minimum range based on the high angle capability. Therefore, it is considered to have no minimum range capability for indirect fire.

<sup>8</sup>75-MM Pack Howitzer M1A1, op. cit., pp. 158-159.

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The howitzer is small: fifty inches in width, thirty-one inches in height, and 126 inches in length when in the traveling position, permitting two of the howitzers to be carried, internally, by one CH-47A helicopter. Also, because of the capability of being disassembled into light weight components, it can be carried by the UH-1D. The pack howitzer also can be carried complete by the CH-34A. The high explosive projectile weighs fourteen pounds, which is only five pounds more than the shell of the 81-mm mortar and, therefore, the 75-mm pack howitzer has relatively little "punch." The howitzer does not have a swim capability but can be floated across deep streams. In summary, the advantages and disadvantages of the use of the 75-mm pack howitzer are as follows:

1. Advantages:

- a. It can fire a variety of fuzes.
- b. It can fire direct fire.
- c. It can fire in a complete circle (6,400 mils). To fire 6,400 mils, the trail must be shifted but this can be accomplished in very few seconds.
- d. It can be fired quite rapidly.
- e. It is small and light weight. It can be towed by a one-quarter ton truck or carried, complete, by either of the cargo helicopters.
- f. It can be disassembled into seven loads, none of which weighs over 250 pounds and, thus, can be lifted by the UH-1D or moved by pack animals.

2. Disadvantages:

- a. It is relatively inaccurate.

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- b. There is no illuminating shell for the howitzer.
- c. It cannot fire high angle fire unless emplaced on a slope.
- d. It has a relatively short range.
- e. It cannot fire indirect fire at short ranges because of the lack of a high angle capability.
- f. It must be floated across streams.

105-mm Howitzer, M101A1, Towed (Figure 13)

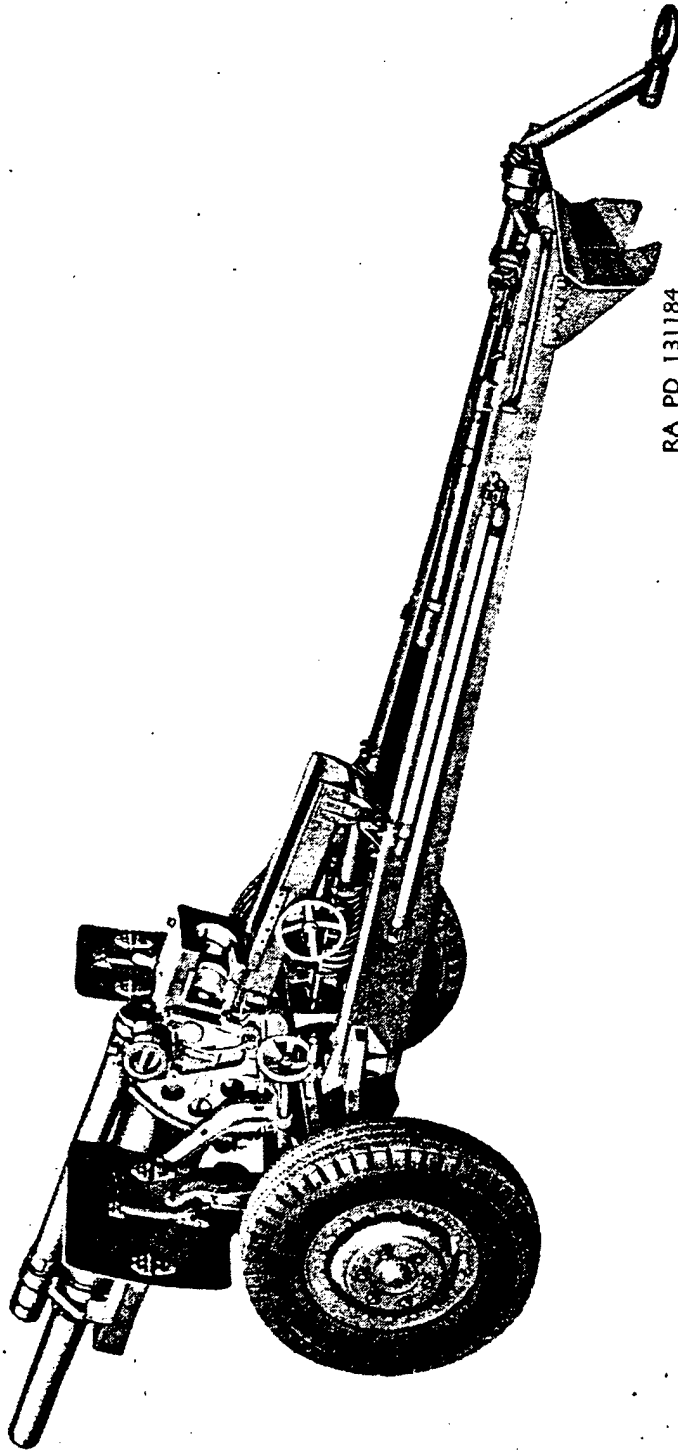
The 105-mm howitzer is the organic direct support weapon of the infantry division. It has been used for many years and is a proven weapon in conventional warfare, but is it the most desirable weapon for counter guerrilla warfare?

The 105-mm howitzer is relatively accurate. The weapon has a probable error, at maximum range, of twenty-one meters in range and nine meters in deflection. It can fire a variety of fuzes and shells. It can fire all the various type fuzes and projectiles (high explosive, gas, anti-tank, illuminating, leaflet, white phosphorous, and smoke shells of various colors). It can fire high angle fire and has a minimum range for indirect fire of 1,600 meters. The traverse limits of the howitzer are 409 mils right and 400 mils left of center, or a total of slightly over forty-five degrees. As with the 75-mm pack howitzer, a spade trench can be dug around the position but this will require much digging--perhaps seventy-five feet of trench. If a trench is dug, it would take slightly longer to shift trails than to shift the trail of the pack howitzer because of the size of the 105-mm howitzer. The 105-mm howitzer can be emplaced quite rapidly -- only three minutes. Other than spreading the trails and laying the weapon for direction, there is very little else which must be done to emplace the weapon. The howitzer has a range which

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Fig. 13.--105-mm howitzer M2A1<sup>9</sup>

<sup>9</sup>U. S., Department of the Army, 105-mm Howitzer M2A1, 105-mm Howitzer Recoil Mechanisms M2A1, M2A2, and M2A3, 105-mm Howitzer Carriages M2A1 and M2A2, and 105-mm Howitzer Mounts M4 and M4A1, Technical Manual 9-3007 (Washington, D. C.: Department of the Army, 1953), p. 8.

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is about 20 per cent greater than the 75-mm pack howitzer. It can fire quite rapidly: ten rounds per minute for the first three minutes and one-and-a-half rounds per minute thereafter. The howitzer is normally towed by a two-and-a-half ton truck. The two-and-a-half ton truck is 93 inches wide, 111 inches high, and 261 inches long.<sup>10</sup> Hence, the prime mover is some nine inches wider and fifty-one inches higher than the weapon. Such a large prime mover greatly increases the problem of moving along jungle trails.

The howitzer is light enough and small enough to be transported externally, as well as internally, by the CH-47A helicopter. Even if disassembled into components though, the howitzer can not be carried by the CH-34A or the UH-1D in mountain operations. It is also doubtful if the howitzer can be moved by the CH-34A or the UH-1D in jungle operations in the tropics. The 105-mm howitzer has been successfully moved, many times, at Fort Sill by the CH-34A when disassembled into three components. The weight of each component is as follows:

1. Tube and recoil mechanism - 1,440 pounds.
2. Section chest and breech block - 140 pounds.
3. Gun carriage and two lifting bars - 3,000 pounds.<sup>11</sup>

The lift capability, however, of the CH-34A, which is powered by a reciprocating type engine, is limited by the dew point temperature as well as the density altitude. The high dew point temperature encountered in the tropics, in contrast to the low dew point temperature

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<sup>10</sup>U. S., Department of the Army, Military Tactical Vehicles, Technical Manual 9-236 (Washington, D. C.: Department of the Army, 1960), p. 113.

<sup>11</sup>U. S., Army Artillery and Missile School, Report: Field Experiment, Helicopter Transported Artillery Units, CDOG Project 58-T2 (Fort Sill: U. S. Army Artillery and Missile School, 1958), Inclosure 1 to Test No. 2, n. p.

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in the Fort Sill area, greatly reduces the lift capability of the CH-34A. As computed from Technical Manual 55-1520-202-10, for a cruise altitude of 2,000 feet, an ambient temperature of ninety-five degrees Fahrenheit, a dew point temperature of ninety-degrees Fahrenheit, and a range of 92.5 kilometers, the CH-34A can lift only 2,200 pounds. For a range of 55 kilometers, it can lift only 2,500 pounds under these conditions. Thus, the CH-34A can not lift the unassembled gun carriage under these conditions. When disassembled into three components, about fifteen minutes are required to reassemble the howitzer.<sup>12</sup> Any increase in reassembly time due to further disassembly of the howitzer, would negate the advantages of moving the weapons by helicopter and possibly permit the position area to be attacked before the weapons are capable of firing.

The high explosive projectile, weighing about thirty-three pounds, has an effective burst diameter of about thirty meters.<sup>13</sup> The 105-mm howitzer does not have a swim capability so it must be floated across deep streams. To summarize, the advantages and disadvantages of the use of the towed, 105-mm howitzer, M101A1, in counterguerrilla warfare are:

1. Advantages:

- a. It is relatively accurate.
- b. It can fire a variety of fuzes.
- c. It can fire a variety of shells.

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<sup>12</sup>Ibid., pp. 1-2.

<sup>13</sup>U. S., Army Artillery and Missile School, Study: Requirements for the Development of Field Artillery Weapons for the Period 1965-70 (U) (Fort Sill: U. S. Army Artillery and Missile School, 1962), p. H-39.

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- d. It can be fired quite rapidly.
- e. It can be moved, externally or internally, by the CH-47A.
- f. It can fire high angle fire.
- g. It can fire direct fire.
- h. It has a relatively long range capability.
- i. It has a minimum range for indirect fire which is quite

short.

- j. It has a relatively heavy projectile.

2. Disadvantages:

- a. It is relatively large and heavy.
  - b. It cannot fire in a complete circle without shifting
- trails.
- c. Its prime mover is large.
  - d. It cannot be moved by the CH-34A or the UH-1D.
  - e. It must be floated across streams.

105-mm Howitzer, M102, Towed (Figure 14)

The M102, a relatively new weapon, is the organic direct support weapon of the airborne division and was used in the test of the air assault division. The section crew consists of nine personnel, the same number as the crew of the M101A1. As is indicated in Table 7, the M102 can fire extended range ammunition as well as the regular 105-mm ammunition.

The M102 is relatively accurate. For regular 105-mm ammunition, it has, at maximum range, a probable error of eighteen meters in range and three meters in deflection. For the extended range ammunition, the accuracy decreases slightly to twenty-eight meters in range and nine

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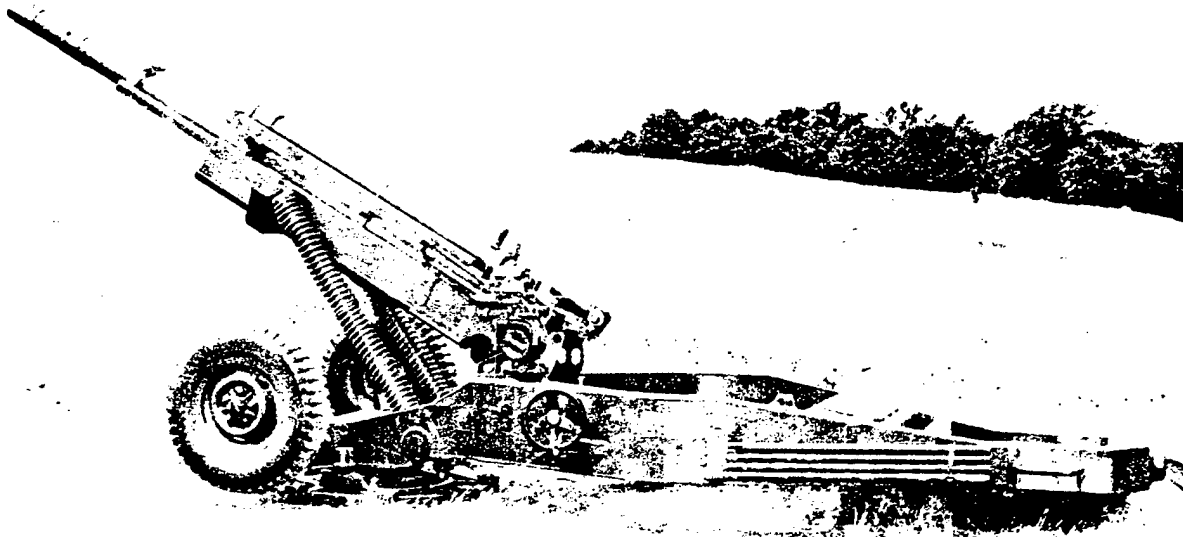


Fig. 14.--105-mm Howitzer light, M102, towed<sup>14</sup>

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<sup>14</sup>U. S., Department of the Army, 105-mm Howitzer Light, M102, Towed, Field Manual 6-70 (Washington, D. C.: Department of the Army, 1964), p. 2.

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meters in deflection.<sup>15</sup> It is capable, as are the two weapons already discussed, of firing a variety of fuzes. Since the M102 fires the same ammunition, it has all the shell capability which the M101A1 has. As of May 1964, only the high explosive shell with point detonating fuze was developed for the extended range ammunition, but other type shells and fuzes are being developed.<sup>16</sup> It can also fire high angle fire and direct fire. The maximum on-carriage traverse is only 178 mils right and left of center. To enable it to fire in a complete circle, the wheels of the howitzer are jacked from the ground and the howitzer rests on a circular base. Spades on the base prevent movement of the howitzer when it is fired. Further, spikes can be driven through the base to increase the stability of the weapon during firing. All that is required to fire in a complete circle is to rotate the trail around the base. Because of the fixed base, the movement is accomplished more rapidly and accurately than the same movement with the 75-mm pack howitzer or the 105-mm howitzer, M101A1. Because of the ease in traversing 6,400 mils (a complete circle), its traverse limits are listed as 6,400 mils in Field Manual 6-40. The M102 can be emplaced rapidly, although emplacement takes one minute longer than emplacement of the M101A1. With the use of extended range ammunition, the M102

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<sup>15</sup>Using normal 105-mm ammunition, the M102 is considerably more accurate than either the pack howitzer or the M101A1. Using extended range ammunition, the M102 is slightly less accurate than either of the two weapons. It should be realized, though, that the small difference in accuracy occurs at a range which is almost twice as great as the maximum range of the pack howitzer and almost one-and-a-half times as great as the maximum range of the M101A1, See supra, p. 73.

<sup>16</sup>U. S. Army Artillery Board, Service Test, Letter Report for Cartridge, 105-mm, HE, XM482, DA Project No. 5W04-03-026, USATECOM Project No. 2-3-0030-02, USAARTYBD Project No. FA 2359-1 (U) (Fort Sill: U. S. Army Artillery Board, 1964), p. 2.

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has about a 30 per cent greater range than the M101A1 and about a 70 per cent greater range than the 75-mm pack howitzer. Using the normal 105-mm ammunition, minimum range (using high angle fire) is 2,300 meters, which is only a slightly greater distance than that of the M101A1. According to a service test in 1964, its minimum high angle range for extended range ammunition is 2,000 meters; but a new propelling charge, which is under development, is designed to provide a minimum high angle range of 1,000 meters.<sup>17</sup> The M102 has a relatively high rate of fire. For the first three minutes it can fire ten rounds per minute, and thereafter it can fire three rounds per minute. Because of its light weight, it can be towed by a three-quarter ton truck. The three-quarter ton truck is 73- $\frac{1}{2}$  inches wide, 89- $\frac{1}{2}$  inches high and 189- $\frac{1}{2}$  inches long,<sup>18</sup> and, therefore, is only 2- $\frac{1}{2}$  inches wider and 29- $\frac{1}{2}$  inches higher than the weapon. Also, by removing the canvas from the vehicle and putting the windshield down, the height of the truck can be reduced by twenty-six inches which then makes it only three-and-a-half inches higher than the weapon. The M102 is small and light enough to be transported, complete, either externally or internally, by the CH-47A. However, as is the case of the M101A1, the M102 cannot be moved by either the CH-34A or the UH-1D. The M102 does not have a swim capability so it must be floated across deep streams. The lethality of the extended range, high explosive shell is about twice that of the normal 105-mm high explosive shell.<sup>19</sup> To summarize, the advantages and disadvantages

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<sup>17</sup>Ibid., p. 3.

<sup>18</sup>Military Tactical Vehicles, op. cit., p. 111.

<sup>19</sup>Development of 105mm High Explosive Shell, M442 (T388) (U), op. cit., pp. 6-8.

of the 105-mm howitzer, M102, are:

1. Advantages:

a. It is quite accurate, more so than the M101A1 when firing the M1 shell and slightly less accurate when firing the extended range ammunition.

b. It can fire a variety of shells and fuzes when firing the normal 105-mm ammunition but only the high explosive shell with a point detonating fuze has been developed to date for the extended range ammunition.

c. It can be fired quite rapidly.

d. It can be moved, externally or internally, by the CH-47A.

e. It can fire high angle fire.

f. It can fire direct fire.

g. It can fire 6,400 mils with a minimum amount of time wasted in shifting the trail.

h. It can be emplaced rapidly from a traveling position.

i. It has a long range, especially when firing the extended range ammunition.

j. It is relatively small and light.

k. It has a large lethal area.

l. It can be towed by a small prime mover.

2. Disadvantages:

a. It cannot be moved by the CH-34A or the UH-1D.

b. It must be floated across streams.

## 105-mm Howitzer, M104, Self-Propelled (Figure 15)

The M104 is the self-propelled version of the M102.<sup>20</sup> The M104 is a full-tracked vehicle with the M103 cannon mounted on it, "developed as a direct-support weapon for infantry and airborne divisions of the 1965-1970 Army."<sup>21</sup>

Essentially, the M104 is a gun platform on tracks. Its light weight is achieved through the elimination of any armor protection for the crew members. It has the same capabilities as the M102 of accuracy, being able to fire a variety of fuzes and shells, high angle fire, direct fire, range, and rate of fire. The on-carriage traverse is 398 mils right and left of center or a total of about forty-five degrees. But, as with all tracked-mounted artillery weapons, it can be moved rapidly to fire in a complete circle. It will take longer to move the howitzer for direction than it takes to move the M102, but it still can be accomplished quite rapidly. The emplacement time listed in Table 7 is five minutes but the Technical Information Report states the emplacement time as one minute.<sup>22</sup> It is inconceivable to the author that it would require more time to emplace the M104 than the M102. It probably takes about three or four minutes to emplace the M104, with most of this time being used to lay the weapon for direction. It is a full-tracked weapon, only 63 inches in width, 78 inches in height, and 145

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<sup>20</sup>It should be understood that all self-propelled artillery weapons are not necessarily on tracked vehicles or even on a vehicle at all. The Honest John, for instance, is a self-propelled artillery weapon, but the launcher is mounted on a wheeled vehicle. A power unit has been tested on the trail of the M101A1 to permit movement in the position area without using a vehicle; this is a self-propelled weapon.

<sup>21</sup>Development of 105mm Self-Propelled Light Howitzer, XM104 (U), op. cit., p. 1.

<sup>22</sup>Ibid.

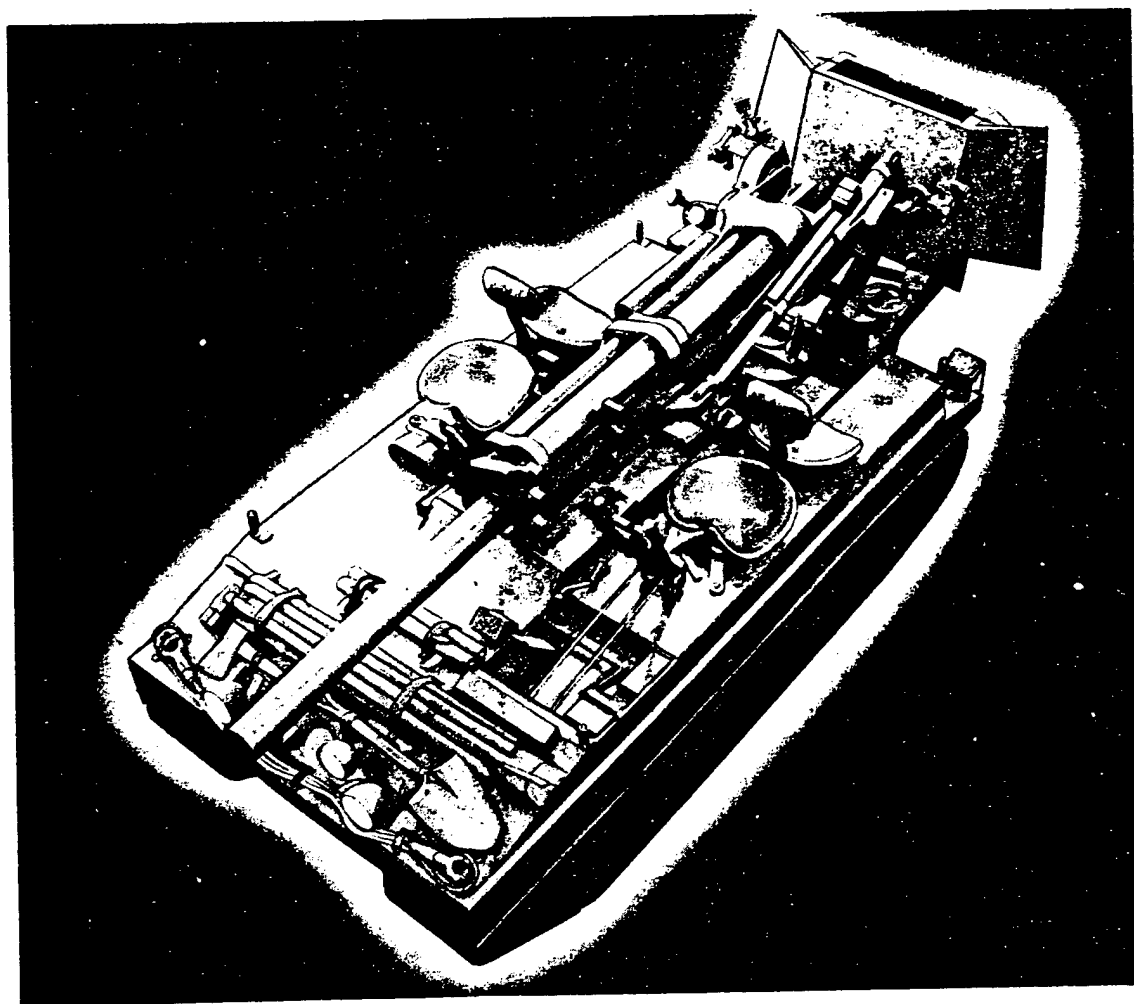


Fig. 15.--105-mm Self-propelled light howitzer, M104<sup>23</sup>

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<sup>23</sup>U. S., Office of the Chief of Ordnance, Development of 105-mm Self-Propelled Light Howitzer, XM104 (U), Technical Information Report 3-2-113 (Washington, D. C.: Office of the Chief of Ordnance, 1961), p. 3.

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inches in length. It weighs 7,500 pounds when combat loaded, but this can be reduced to 6,000 pounds by removing the crew and ammunition, for air movement. Therefore, it can be transported, either internally or externally, by the CH-47A helicopter. This is assuming the dimensions contained in the various publications are correct. If the dimensions are not correct, the howitzer could not be carried internally since the height of the cargo compartment of the CH-47A is exactly the same height as the weapon. The weapon cannot be moved by the CH-34A or the UH-1D. According to the Technical Information Report, a "flotation kit gives the vehicle an unlimited fording capability."<sup>24</sup> To summarize, the advantages and disadvantages of the M104 are as follows:

1. Advantages:

- a. It is quite accurate, more so than the M101A1 when firing the M1 shell and slightly less accurate when firing the extended range ammunition.
- b. It can fire a variety of shells and fuzes when firing the normal 105-mm ammunition but only the high explosive shell with a point detonating fuze has been developed to date for the extended range ammunition.
- c. It can be fired quite rapidly.
- d. It can be moved, externally or internally, by the CH-47A.
- e. It can fire high angle fire.
- f. It can fire direct fire.
- g. It can be emplaced rapidly from a traveling position.
- h. It has a long range, especially when firing the extended range ammunition.

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<sup>24</sup>Ibid., p. 2.

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- i. Its shell has a large lethal area.
  - j. It is full-tracked, self-propelled.
  - k. It has an unlimited fording capability.
2. Disadvantages:
- a. It is heavy.
  - b. It cannot be moved by the CH-34A or the UH-1D.

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## CHAPTER VI

### SELECTION OF MOST DESIRABLE WEAPON

In the previous chapter, several weapons are compared based on desirable characteristics determined in Chapters III and IV. Table 8 is a comparison of the weapons discussed with the desired capabilities or characteristics.

A number one is given to the weapon which is considered best for each of the capabilities, a number two to the next best, and so on. This chapter determines, based on the data in Table 8, which of the four field artillery weapons is best suited for counter guerrilla warfare.

One proposal for determining the weapon best suited for counter guerrilla warfare is to add up the numbers in the columns in Table 8, and the weapon with the lowest total would be considered the best. Such a procedure is acceptable if all the capabilities are of equal importance. Since being a tracked vehicle, for instance, is of greater importance than the time required to emplace the weapon, this method does not suffice. Another proposal is to assign values, based on their relative importance, to each of the seventeen capabilities and multiply these values by the numbers contained in Table 8. Adding the columns, after the multiplication, would be an approximation of the relative worth of the weapons for counter guerrilla warfare. The problem with this method is the absence of certain capabilities for certain of the weapons. With both of the foregoing proposals being rejected, the method used is a discussion of the major advantages and disadvantages of each of the

TABLE 8

COMPARISON OF WEAPONS FOR DESIRABLE CHARACTERISTICS

	M116	M101A1	M102	M104
1. Accuracy	(3)	2	[1]	[1]
2. Fuzes available	1	1	1	1
3. Shells available	(2)	1	1	1
4. High angle fire	(-)	1	1	1
5. Direct fire capability	1	1	1	1
6. 6,400 mils firing	3	4	[1]	2
7. Time for emplacement	4	2	3	1
8. Long range	(3)	2	[1]	[1]
9. Short range	-	3	2	2
10. High rate of fire	4	3	2	2
11. Full-tracked	2	(2)	(2)	[1]
12. Small (in size)	[1]	(5)	[4]	[2]
13. Light weight	[1]	(4)	[2]	(5)
14. Transportable by CH-47A	1	1	1	1
15. Transportable by CH-34A (disassembled)	1	-	-	-
16. Transportable by UH-1D (disassembled)	1	-	-	-
17. Swim capability	2	2	2	[1]

[ ] Major Advantage

( ) Major Disadvantages

weapons (though not necessarily the lowest or highest number contained in Table 8).

A major advantage or disadvantage is based on the relative importance of the capabilities themselves as well as the relative difference, between weapons, for a given capability. For instance, in Table 8, the 75-mm pack howitzer is given a two for the capability of having a variety of shells made for the weapon and a four for the time required to emplace the weapon, but the unavailability of shells is considered to be a major disadvantage while emplacement time is less significant, for two reasons. First, having a variety of shells is considered to be more important than the emplacement time; and secondly, the difference in emplacement times between any two of the weapons is relatively small.

Two of the capabilities, direct fire and movement by the CH-47A helicopter, can be eliminated from future discussion since all the weapons have these capabilities.

The authors of an article entitled "Artillery vs. Guerrillas" in the Marine Corps Gazette state that the 75-mm pack howitzer is a good weapon which has not been used "to its full capabilities during the past few years and its use might become commonplace in counterguerrilla warfare."<sup>1</sup> Is this really the weapon for operations against guerrillas?

The major advantages of the 75-mm pack howitzer, when compared to the other three weapons, are its size and weight. Because of its size and weight the howitzer, or its components, can be moved by all three helicopters, by small vehicles, or by pack-animals. This is a

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<sup>1</sup>C. R. Leach and C. J. O'Shea, "Artillery vs. Guerrillas," Marine Corps Gazette, September 1962, p. 50.

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tremendous capability in the type terrain under consideration. Because the pack howitzer is small and light and can be moved by various modes of transportation, it is not considered to be a major disadvantage that the howitzer is not full-tracked. Neither the jungles nor the mountains are a significant obstacle to a weapon which can be moved by any means being considered. The major disadvantages of the pack howitzer are its relative inaccuracy, absence of an illuminating shell, the inability to fire high angle fire, and the short range. Although the lack of accuracy and the short range are tolerable, accuracy and range are of importance. At maximum range, 75 per cent of the rounds fired can be expected to fall outside a rectangle, the center of which is the target, which is sixty-four meters long and fourteen meters wide. Even though the accuracy of the fire placed on the guerrillas is not considered to be very important (Chapter III), accuracy is important from the point of safety for the friendly troops as well as for civilians. To effectively support offensive operations, frequent displacement, because of the short range of the pack howitzer, is required. Inherent in displacements are the problems of road ambushes, clearing position areas, and attacks before the position area defense can be established. The reasons for desiring an illuminating shell and a high angle fire capability were discussed in detail in Chapter III.

The M101A1, when compared to the other weapons, has no major advantages. It is a better weapon in a few respects than the pack howitzer, such as range, accuracy and emplacement time, but is superior to the M102 in only one capability -- emplacement time. It requires only one minute less to emplace the M101A1 than to emplace the M102; and, therefore, emplacement time is not considered a significant advantage. The major disadvantages of the M101A1 are its size and weight, and the

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absence of a full-tracked vehicle. Its size limits its usefulness along jungle trails and its weight requires a prime mover which is larger than the weapon itself. Because it is not full-tracked, the mobility of the M101A1 in the jungles and the mountains is considered to be poor.

The M102 has numerous advantages over the pack howitzer and the M101A1. Its major advantages, however, are its range, accuracy, size, weight, and capability of firing in a complete circle. Its long range results from the capability to fire extended range ammunition. When using normal 105-mm ammunition, it is much more accurate than the 75-mm pack howitzer. About 67 per cent of the rounds fired by the M102 are expected to fall in an area slightly smaller (thirty-five square meters) than the area in which the 75-mm pack howitzer can place only 25 per cent of its rounds. Figure 16 depicts the relationship between the accuracies of the 75-mm pack howitzer, the M101A1, the M102, and the M104. In the figure, 25 per cent of the rounds fired, with a given weapon, are expected to fall within the areas shown. When firing the normal 105-mm ammunition, the M102 is considerably more accurate than the M101A1 or the pack howitzer. The size and weight of the M102 permit it to be moved by a relatively small prime mover and allow two of the weapons to be moved, internally, by the CH-47A. The capability of firing in a complete circle by rotating the weapon around the base gives an almost instant response to fire requests at any direction, either direct or indirect fire. The major disadvantage of the M102 is its not being a tracked vehicle. Because of this, and because the howitzer cannot be disassembled into small loads, the mobility of the M102 is poor as far as operations in the jungles and mountains are concerned.

The M104 has the major advantages of range, accuracy, size, and

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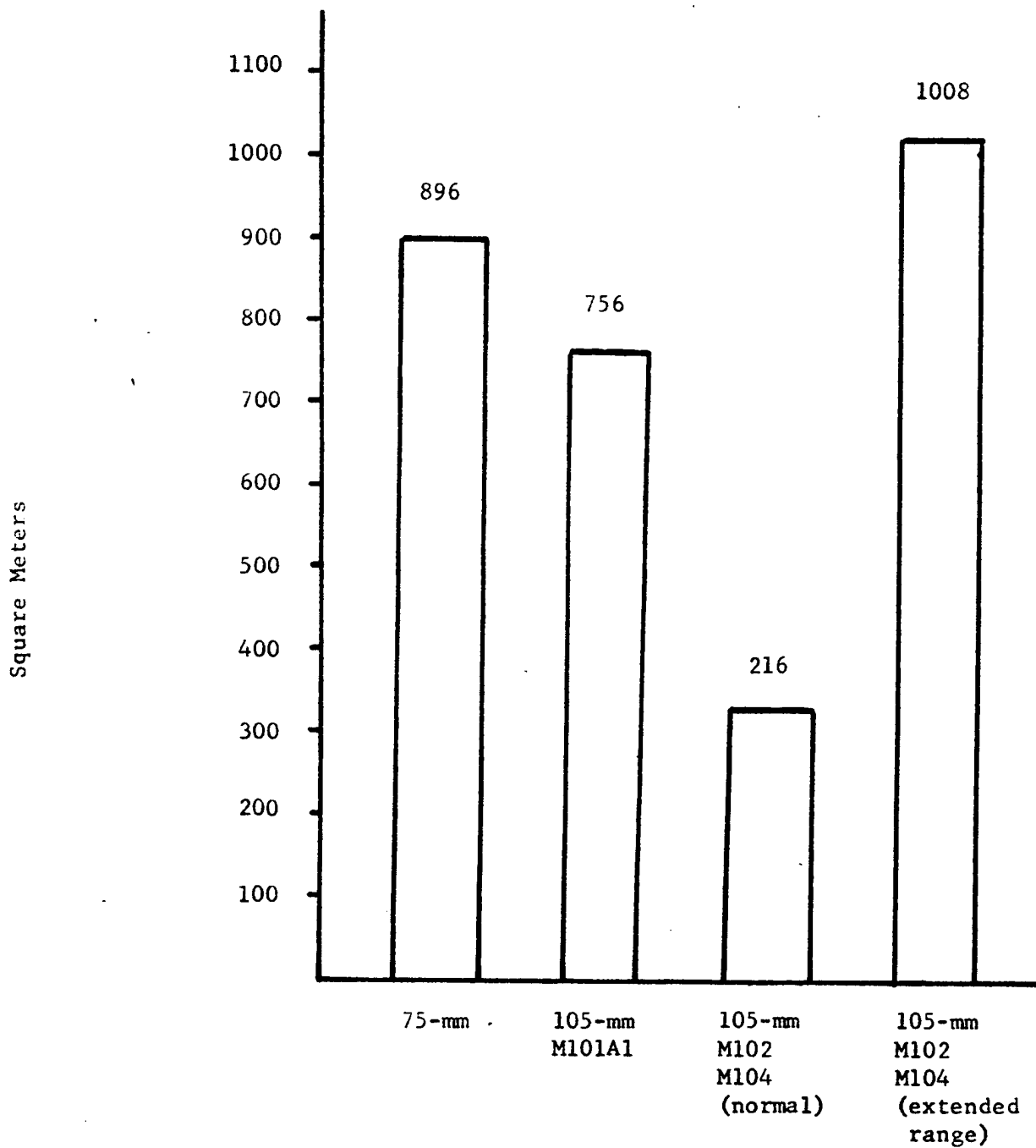


Fig. 16.--Areas in which twenty-five per cent of the rounds fired will fall. (Maximum range).

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the feature of being a full-tracked vehicle which has an unlimited fording capability. Since it mounts the same cannon as the M102, the M104 has the same range and accuracy as the M102. The M104 is a small vehicle: 8 inches narrower, 113 inches shorter and only 18 inches higher than the M102. The size of the M104 becomes more pronounced when compared to the 75-mm pack howitzer. The M104 is only about one foot wider, four feet higher, and three feet longer than the pack howitzer. A more realistic comparison is to compare the M104 with the 75-mm pack howitzer while the pack howitzer is coupled to its prime mover, a one-quarter ton truck. When compared in this manner, the M104 is about the same width, two feet taller and about nine feet shorter. The other major advantages of the M104 are its full-tracked feature and its unlimited fording capability. This gives it the mobility which the other weapons do not possess. It can cross deep streams without the necessity of rigging it for floating. The M104 has all the inherent mobility advantages which a tracked vehicle has over a wheeled vehicle. Figure 17 depicts the relative mobility of the M104 and the M102 when the latter is towed by a 1-½ ton truck. The mobility advantage of the M104 is quite pronounced. The major disadvantage of the M104 is its weight. It is the heaviest of the weapons considered. Even when stripped for air movement, the operation in which weight is important, the M104 still weighs some 6,000 pounds or twice as much as the M102.

Table 9 summarizes the major advantages and disadvantages of the weapons discussed.

Of the four weapons considered the 105-mm howitzer, M104, is considered to be the best weapon for use in counter guerrilla warfare. The M104 is superior to the other weapons in mobility, maneuverability, and obstacle crossing ability, and inferior to the other weapons in

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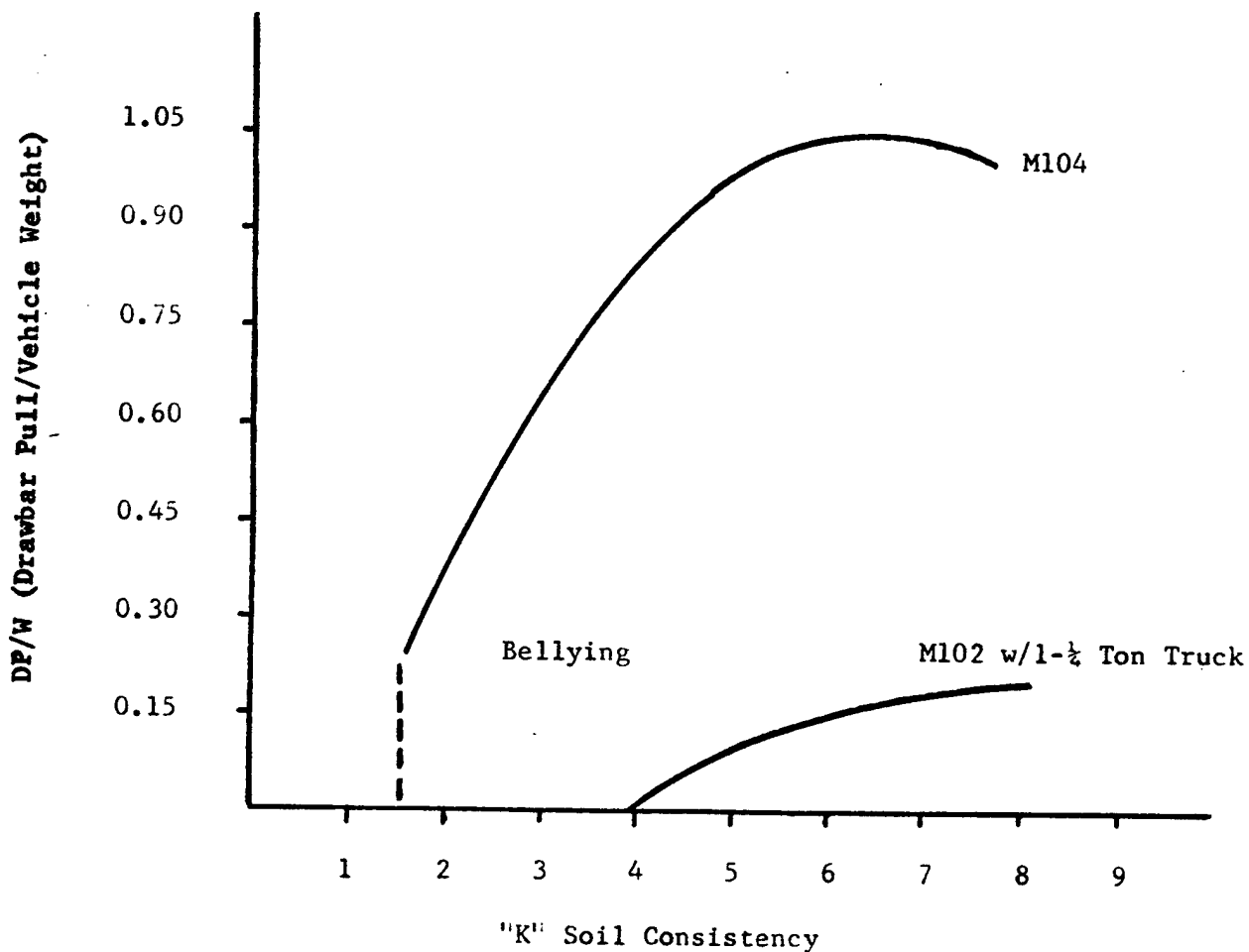


Fig. 17.--The relative mobility of the M104 self-propelled howitzer and the M102 howitzer towed by the XM 561, 1- $\frac{1}{2}$  ton truck.<sup>2</sup>

<sup>2</sup>U. S. Army Artillery and Missile School, Briefing: SP vs Towed and Accompanying Vehicles (Fort Sill: United States Army Artillery and Missile School, n. d.), n. p.

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TABLE 9

## MAJOR ADVANTAGES AND DISADVANTAGES OF THE 75-MM PACK HOWITZER

AND THE 105-MM HOWITZERS, M101A1, M102, and M104

	M116	M101A1	M102	M104
Major Advantages	1. Size	None	1. Range	1. Range
	2. Weight		2. Accuracy	2. Accuracy
			3. Size	3. Size
			4. Weight	4. Full-tracked
			5. 6,400 mil capability	5. Unlimited fording capability
Major Disadvantages	1. Accuracy	1. Size	1. Wheeled	1. Weight
	2. Shells available	2. Weight		
	3. Lack of high angle capability			
	4. Range			

weight. The M102 is considered to be the second best weapon. The M102 is superior to the pack howitzer and the M101A1 in range, accuracy, and ability to fire rapidly in a complete circle.

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## CHAPTER VII

### PERSONNEL

In Chapter III the following requirements, which concern personnel, were determined:

1. The artillery battery must be capable of being employed by platoons.
2. Sufficient observers must be available to insure that the combat elements which need fire support actually have the observers.
3. Sufficient security personnel must be assigned or attached to provide position area security.

This chapter determines the personnel changes to the present TOE of the 105-mm howitzer battalion required to satisfy these requirements.

#### Employment by Platoons

Inherent in the requirement for employing the field artillery by platoons is the need for sufficient fire direction personnel. Additional personnel are required for technical fire direction, which is the conversion of fire missions received in the fire direction center (FDC) into fire commands, rather than additional personnel for tactical fire direction, which is the selection of targets and the designation of units to fire. Technical fire direction is composed of the following functions:

1. Receiving the fire mission from a forward observer or higher headquarters.
2. Plotting the mission on a map or chart.

3. Determining the range and direction to the target.
4. Determining the vertical data.
5. Converting the map or chart data into firing data.
6. Transmitting the fire commands to the howitzer section(s).
7. Keeping the necessary records, such as ammunition expenditure.

The FDC of a 105-mm howitzer battery (TOE 6-157E) has the following personnel available to perform the seven functions of technical fire direction:

1. Two officers (the executive officer and the assistant executive officer).
2. One fire direction computer.
3. Two chart operators.
4. One recorder.
5. One radio/telephone operator.<sup>1</sup>

These seven personnel must be prepared to operate the FDC continuously. Since the minimum number of personnel required to perform the technical fire direction functions is three (a supervisor, a chart operator, and a computer), there are sufficient personnel assigned to the battery to continuously operate only one FDC (assuming two shifts of twelve hours each). If each platoon is to have a FDC, at least eleven more personnel are needed for each battery or thirty-three for the battalion.

Thirteen of the additional thirty-three personnel required for the battery FDC's can be obtained from the battalion FDC. If two or

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<sup>1</sup>U. S., Department of the Army, Field Artillery Battery 105-mm, Towed, Field Artillery Battalion Infantry Division or Field Artillery Battery 105-mm, Towed, Field Artillery Battalion Separate Infantry Brigade, Table of Organization and Equipment No. 6-157E (Washington, D. C.: Department of the Army, 1963), p. 7.

three of the batteries are operating detached from the battalion, there is no need for a battalion FDC. If only one battery is operating detached from the battalion, it is desirable, but not necessary, to have the battalion FDC control the fires of the two remaining batteries; the battalion FDC can exercise tactical fire direction while the batteries exercise technical fire direction. Also, assuming each of the batteries has sufficient personnel to operate three platoon FDC's, when only one battery is detached from the battalion, sufficient personnel for the battalion FDC can be obtained from the two remaining battery FDC's since they would have no need for the extra FDC personnel. Therefore, the net increase of FDC personnel required to give the battalion the capability to employ the howitzers by platoons is twenty.

#### Observers

In Chapter II it was assumed the force being supported consisted of three infantry battalions; and, therefore, each of the field artillery batteries must be capable of supporting one infantry battalion with the necessary forward observer sections. The infantry battalion is composed of three rifle companies, and each rifle company has three rifle platoons. At what level or size combat element is an observer section required? Based on the discussion of guerrilla and counter guerrilla tactics, there should be at least three observer sections for each rifle company, or one per platoon. Each rifle company is then assured of having sufficient observers for three patrols.

An observer section is normally composed of an observer, a reconnaissance sergeant, and a radio/telephone operator who is also the driver. For counter guerrilla operations, since the use of vehicles and wire communications is minimal, two personnel are believed to be

sufficient for an observer section: an observer and one enlisted man who is capable of adjusting fire and operating a radio. Hence, a total of nine observer sections, or eighteen personnel, are required for each field artillery battery.

The TOE (6-157E) for the field artillery battery has nine personnel assigned to the forward observer sections.<sup>2</sup> Provisions are made to augment the battery with one additional observer section of three personnel when requested and when approved by the Department of the Army.<sup>3</sup> Therefore, six additional observer personnel are required for each battery or eighteen for the battalion.

#### Security Personnel

Position area security, especially in thick jungles, was determined to be a problem in counter guerrilla warfare. The position area security problem is the greatest when howitzer platoons are operating independently.

In counter guerrilla warfare in the jungles, because of the heavy vegetation, a perimeter is established mainly for detecting the approach of guerrillas and warning the personnel in the position area of the threat. Because of the reduced limits of observation and fields of fire in the jungle, the normal perimeter of a "continuous band of grazing fire around the perimeter"<sup>4</sup> is inconceivable. The personnel on the perimeter have the mission of detecting and reporting guerrilla attempts to infiltrate the position area and to engage the guerrillas, by fire,

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<sup>2</sup>Ibid.

<sup>3</sup>Ibid., pp. 7 and 9.

<sup>4</sup>U. S., Department of the Army, Field Artillery Tactics, Field Manual 6-20-2 (Washington, D. C.: Department of the Army, 1962), p. 39.

if possible. The perimeter personnel move back toward the position area if a determined guerrilla attack is launched and, at this time, the howitzers are employed in a direct fire role against the guerrillas.

The perimeter will be relatively near the position area--probably about 100 meters from the center of the position area. The distance from the center of the position area to the perimeter will depend on the nature of the terrain and the denseness of the jungle. If the jungle is relatively sparse, the perimeter is established further from the position area; but, due to the increased observation and fields of fire, no additional personnel are required to occupy the perimeter.

The establishment of a perimeter 100 meters from the battery center results in a perimeter length of approximately 630 meters. To occupy such a perimeter requires six outposts; and, therefore, the personnel of each outpost are responsible for about fifty meters right and left of the outpost. Each outpost is occupied by two personnel and the outposts are in wire communication with each other and with the position area. Normally, trip flares and warning devices are placed in the area between the outposts.

In mountain operations, because of the increased observation and fields of fire due to a lack of vegetation, the perimeter is established further than 100 meters from the position area. Small arms and crew-served weapons are sited to provide an all-around defense. Because of the increased observation and fields of fire, only six outposts are required to establish an effective perimeter for a howitzer platoon.

If six outposts are needed for each position area and the howitzers are employed by platoons, thirty-six personnel are required for each firing battery, or 108 for the battalion.

## CHAPTER VIII

### SUMMARY AND CONCLUSIONS

#### General

The purpose of this thesis was to determine the field artillery mission weapon and organization which can best support a counter guerrilla operation. The conclusions arrived at below are a result of a comparison of four U. S. field artillery weapons with the desirable weapon characteristics and a comparison of the present field artillery organization with the personnel requirements deemed necessary for counter guerrilla operations.

#### Major Item of Equipment

Major factors affecting selection of the best weapon have been evaluated in the thesis proper and are summarized in Table 8. Those factors considered less significant: cost, crew requirements, battle-field survivability, and maintenance requirements, are presented in Appendix III.

The 105-mm howitzer, M104, equals or exceeds most of the prerequisite requirements for counter guerrilla warfare capabilities of the other light U. S. field artillery weapons. Because it is a tracked vehicle, it is superior in the important capabilities of mobility, maneuverability, and obstacle crossing ability. Therefore, the M104 is considered to be the most effective field artillery direct support



weapon for counter guerrilla warfare. The M102 is considered to be the second best weapon because of its light weight and small size, in addition to possessing many of the capabilities of the other weapons.

### Personnel

It has been determined that for counter guerrilla operations, the field artillery battalion requires 146 additional personnel: 20 FDC personnel, 18 observer personnel, and 108 personnel for position area security.

There are sources within the present organization of the field artillery battalion which can supply some of the additional personnel required. On the assumption that the M104 howitzer is the organic weapon and an accompanying vehicle with a driver is assigned to each howitzer section, there are eighteen excess personnel in the present howitzer sections of the battalion. Since survey and radar are of limited use, especially in the jungles, the personnel provided by the TOE for these functions can be readily cross-trained in FDC procedures in order to provide the additional personnel which are needed in counter guerrilla operations.

When additional personnel for position area security are needed, they must be obtained from outside sources as it would be wasteful to permanently assign 108 personnel to the field artillery battalion who will not be required in all situations.

### Conclusions

Accordingly, it is concluded that:

1. The 105-mm howitzer, M104, is the best field artillery weapon for the direct support mission in counter guerrilla warfare.

2. The 105-mm howitzer, M102, is the next best weapon.

3. The eighteen excess personnel in the howitzer sections, which results from using the M104, should be added to the observer sections and the necessary changes in grade and military occupational specialty (MOS) be made.

4. Twenty of the thirty survey and radar personnel in the battalion should be cross-trained in FDC procedures.

5. An infantry squad should be attached to each platoon of howitzers for position area security when the field artillery is employed by platoons.

## APPENDIX I

### DEFINITIONS

In any discussion of special warfare it is necessary to define certain terms which are peculiar to this type of warfare. The terms defined below are those terms which are likely to be unfamiliar to the reader.

1. Civic action. Civic action, an aspect of civil affairs, is any function performed by military forces in cooperation with civil authorities, agencies, or groups through the use of military manpower and material resources for the socio-economic well-being and improvement of the civil community with a goal of building or reinforcing mutual respect and fellowship between the civil and military communities.<sup>1</sup>

2. Counter guerrilla warfare. Operations and activities conducted by armed forces, paramilitary forces or nonmilitary agencies of a government against guerrillas.<sup>2</sup>

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<sup>1</sup>U. S., Department of the Army, Civil Affairs Operations, Field Manual FM 41-10 (Washington, D. C.: Department of the Army, 1962), p. 83.

<sup>2</sup>U. S., Department of the Army, Dictionary of the United States Army Terms, Army Regulation 320-5 (Washington, D. C.: Department of the Army, 1963), p. 115.

3. Counterinsurgency. Those military, paramilitary, political, economic, psychological, and civic actions taken by a government to defeat subversive insurgency.<sup>3</sup>

4. Evasion and escape. The procedures and operations whereby military personnel and other selected individuals are enabled to emerge from an enemy held or hostile area to areas under friendly control.<sup>4</sup>

5. Guerrilla. A combat participant in guerrilla warfare.<sup>5</sup>

6. Guerrilla warfare. Military and paramilitary operations conducted in enemy held or hostile territory, by irregular, predominantly indigenous forces.<sup>6</sup>

7. Insurgency. A condition resulting from a revolt or insurrection against a constituted government which falls short of civil war. In the current context, subversive insurgency is primarily communist inspired, supported or exploited.<sup>7</sup>

8. Irregular forces. Armed individuals or groups who are not members of regular armed forces.<sup>8</sup>

9. Paramilitary forces. Forces or groups which are distinct from the regular armed forces of any country but resembling them in organization, equipment, training or mission.<sup>9</sup>

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<sup>3</sup>Ibid.

<sup>4</sup>Ibid., p. 154.

<sup>5</sup>Ibid., p. 182.

<sup>6</sup>Ibid.

<sup>7</sup>Ibid., p. 202.

<sup>8</sup>Ibid., p. 207.

<sup>9</sup>Ibid., p. 275.

10. Phases of insurgency. The level of intensity of subversive insurgency may be classified in three general phases. There may not be a sharp or pronounced delineation between the three phases of insurgency. Subversion and guerrilla warfare may continue when the third, or final phase of insurgency is reached, to support the final military effort to overthrow the legally constituted government.

a) Phase I. Latent and Incipient Subversion. This ranges from circumstances in which subversive activity is only a potential threat, latent or already incipient, to situations in which subversive incidents and activities occur with frequency in an organized pattern. It involves no major outbreak of violence or uncontrolled insurgent activity.

b) Phase II. Organized Guerrilla Warfare. This phase is reached when the subversive movement, having gained sufficient local or external support, initiates organized guerrilla warfare or related forms of violence against the established authority.

c) Phase III. War of Movement. In this phase the insurgency becomes primarily a war of movement between organized forces of the insurgents and those of the established authority.<sup>10</sup>

11. Sublimated war. Operations at the lower extremes of limited war and the upper extremes of cold war involving primarily operations against irregular forces and counterinsurgency operations;

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<sup>10</sup>U. S., Army Combat Developments Command Combined Arms Agency, Final Draft Manuscript; Special Warfare Operations, Field Manual 31-15 (Fort Leavenworth: U. S. Army Combat Developments Command, 1964), pp. 5-6.

United States Army sublimited war operations are designed to defeat Communist activity in a threatened country.<sup>11</sup>

12. Subversion. Action designed to undermine the military economic, psychological, morale or political strength of a regime.<sup>12</sup>

13. Unconventional warfare. Includes the three interrelated fields of guerrilla warfare, evasion and escape and subversion. Unconventional warfare operations are conducted within enemy or enemy controlled territory by predominantly indigenous personnel, usually supported and directed in varying degrees by an external source.<sup>13</sup>

Figure 19 depicts the relationship between most of the terms just defined. Figure 19 shows that unconventional warfare and counterinsurgency are components of special warfare. It also shows that efforts to counter insurgency include control of population and resources, environmental improvement, and counter guerrilla warfare. The population and resources of a country are controlled through the political, economic, psychological, and paramilitary means available in a country. Environmental improvement is accomplished through civic action. The military and paramilitary resources of a country are the actual combatant forces. It should be kept in mind that a guerrilla force cannot be defeated by counter guerrilla warfare alone unless the country has the manpower and resources to occupy the entire country and control the entire population of the country. To effectively wage a war against

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<sup>11</sup>U. S., Army Command and Staff College, A Detailed Concept for Employment of US Army Combat Units in Military Operations Against Irregular Forces (U) (Fort Leavenworth: U. S., Army Command and General Staff College, 1962), p. 1.

<sup>12</sup>Dictionary of United States Army Terms, op. cit., p. 380.

<sup>13</sup>Ibid., p. 410.

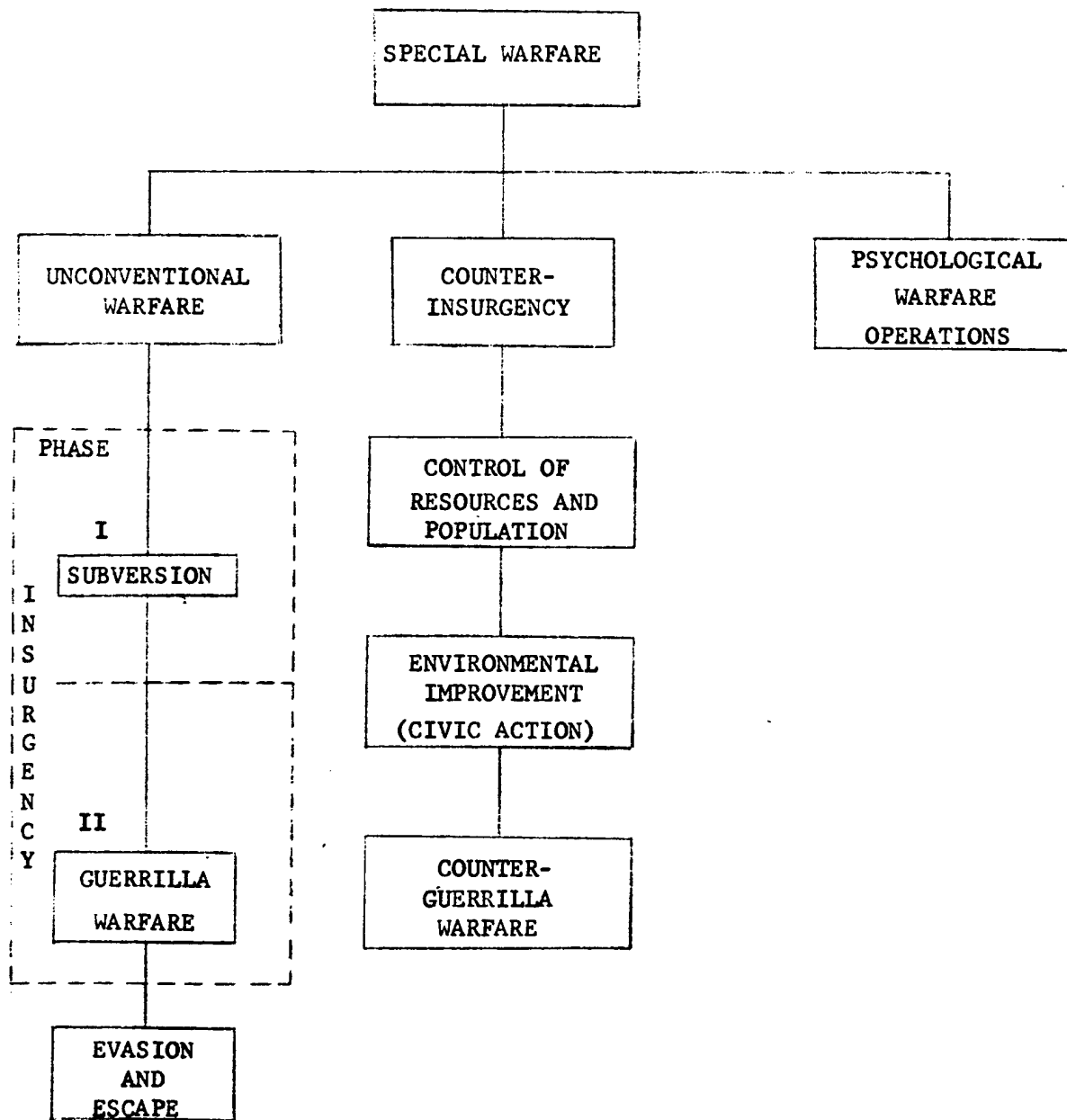


Fig. 18.--Relationship between special warfare terms

guerrilla forces the military operations must be supplemented by political, economic, and psychological actions as well as civic actions. It might be said that military operations assist the political, economic, and psychological factors in the control of subversion while these factors assist the military operations in the fight against the guerrilla forces in Phase II of insurgency operations.



## APPENDIX II

## I. Computations for Figure 9.

A. Determination of pressure altitude for a given pressure and gross load.<sup>1</sup> Wind velocity is assumed to be zero<sup>2</sup> and the dew point temperature is assumed to be ninety degrees Fahrenheit.<sup>3</sup>

Temperature °F	Pressure Altitude (ft)	
	(Gross weight lbs)	
	10,500	12,000
131	2,500	
95	4,000	
59	5,400	2,000
23	7,000	3,500
-13	8,500	5,300

<sup>1</sup>U. S., Department of the Army, Operators' and Crew Members' Instructions Army Model H-34A, H-34C Helicopter, Technical Manual 55-1520-202-10 (Washington, D. C.: Department of the Army, 1962), p. 158.

<sup>2</sup>Any wind velocity would increase the lift capability of the helicopter. Therefore, a zero wind velocity is the worst case.

<sup>3</sup>The lift capability of the CH-34A helicopter is a function of the dew point temperature. Based on the maximum mean relative humidity found in South Vietnam (National Intelligence Summary, South Vietnam, Section 23: Weather and Climate (U) /Washington, D. C.: Central Intelligence Agency, 19597, pp. 23-24), the maximum mean dew point temperature is ninety degrees Fahrenheit. Since the lift capability of the helicopter decreases with an increasing dew point, using the maximum dew point temperature results in the worst case.

B. Determination of net load for a given range and gross weight.<sup>4</sup>

1. Gross weight - 12,000 pounds; range - 92.5 kilometers radius; temperature - 95° Fahrenheit.

Altitude (ft)	Fuel <sup>5</sup> (lbs)	Helicopter and Crew <sup>6</sup> (lbs)	Total Weight <sup>7</sup> (lbs)	Net Load (lbs)
0	726	8,017	8,743	3,257
2,000	774	8,017	8,791	3,209
4,000	813	8,017	8,830	3,170
6,000	893	8,017	8,910	3,090
8,000	990	8,017	9,007	2,993

For the given gross weight and range, a net load of approximately 3,100 pounds can be lifted by the HC-34A helicopter.

2. Gross weight - 10,500 pounds; range - 92.5 kilometers radius; temperature - 95° Fahrenheit.

Altitude (ft)	Fuel (lbs)	Helicopter and Crew (lbs)	Total Weight (lbs)	Net Load (lbs)
0	673	8,017	8,690	1,810
2,000	750	8,017	8,667	1,833
4,000	674	8,017	8,691	1,809
6,000	690	8,017	8,707	1,793
8,000	764	8,017	8,781	1,719

For the given gross weight and range, a net load of approximately 1,800 pounds can be lifted by the HC-34A helicopter.

<sup>4</sup>Operators' and Crew Members' Instructions Army Model H-34A, H-34C Helicopter, op. cit., pp. 160-161.

<sup>5</sup>Fuel weight includes the weight of fuel required to climb to cruise altitude, the weight of fuel consumed on the mission, and the weight of a thirty-minute fuel reserve.

<sup>6</sup>One crew member.

<sup>7</sup>The sum of the fuel, helicopter and crew weights.

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3. Gross weight - 12,000 pounds; range -55 kilometers

radius; temperature - 95° Fahrenheit.

Altitude (ft)	Fuel (lbs)	Helicopter and Crew (lbs)	Total Weight (lbs)	Net Load (lbs)
0	545	8,017	8,562	3,438
2,000	583	8,017	8,600	3,400
4,000	621	8,017	8,638	3,362
6,000	693	8,017	8,710	3,290
8,000	820	8,017	8,837	3,163

For the given gross weight and range, a net load of approximately 3,300 pounds can be lifted by the HC-34A helicopter.

4. Gross weight - 10,500 pounds; range - 55 kilometers

radius; temperature - 95° Fahrenheit.

Altitude (ft)	Fuel (lbs)	Helicopter and Crew (lbs)	Total Weight (lbs)	Net Load (lbs)
0	487	8,017	8,504	1,996
2,000	496	8,017	8,513	1,987
4,000	520	8,017	8,537	1,963
6,000	535	8,017	8,552	1,948
8,000	597	8,017	8,614	1,886

For the given gross weight and range, a net load of approximately 1,950 pounds can be lifted by the HC-34A helicopter.

## II. Computations for Figure 10.

A. Determination of pressure altitude for a given pressure and gross load.<sup>8</sup> Wind velocity is assumed to be zero.

<sup>8</sup>U. S., Department of the Army, Operator's Manual, Army Model HC-1B Helicopter, Technical Manual 55-1520-209-10 (Washington, D. C.: Department of the Army, 1963), chapter 14, p. 2-7.

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Temperature °F	Pressure	Altitude (ft)
	(Gross weight lbs)	
	25,000	30,000
140	1,900	
104	6,200	1,500
68	9,100	4,400
32	11,000	6,200
-4	12,300	7,600

B. Determination of net load for a given range and gross weight.<sup>9</sup>

1. Gross weight - 30,000 pounds; range - 92.5 kilometers radius.

Altitude (ft)	Fuel (lbs)	Helicopter and Crew <sup>10</sup> (lbs)	Total Weight (lbs)	Net Load (lbs)
0	2,631	18,000	20,631	9,369
2,000	2,538	18,000	20,538	9,462
4,000	2,432	18,000	20,432	9,568
6,000	2,239	18,000	20,239	9,761
8,000	2,245	18,000	20,245	9,755

For the given gross weight and range, a net load of approximately 9,600 pounds can be lifted by the CH-47A helicopter.

2. Gross weight - 25,000 pounds; range - 92.5 kilometers radius.

Altitude (ft)	Fuel (lbs)	Helicopter and Crew (lbs)	Total Weight (lbs)	Net Load (lbs)
0	2,448	18,000	20,448	4,552
2,000	2,320	18,000	20,320	4,680
4,000	2,214	18,000	20,214	4,786
6,000	2,120	18,000	20,120	4,880
8,000	2,030	18,000	20,030	4,970

<sup>9</sup> Ibid., chapter 14, pp. 2-8, 2-10 thru 2-11.

<sup>10</sup> Five crew members.

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For the given gross weight and range, a net load of approximately 4,800 pounds can be lifted by the CH-47A helicopter.

3. Gross weight - 30,000 pounds; range - 55 kilometers radius.

Altitude (ft)	Fuel (lbs)	Helicopter and Crew (lbs)	Total Weight (lbs)	Net Load (lbs)
0	1,990	18,000	19,990	10,010
2,000	1,933	18,000	19,933	10,067
4,000	1,857	18,000	19,857	10,143
6,000	1,679	18,000	19,679	10,321
8,000	1,695	18,000	19,695	10,325

For the given gross weight and range, a net load of approximately 10,200 pounds can be lifted by the CH-47A helicopter.

4. Gross weight - 25,000 pounds; range - 55 kilometers radius.

Altitude (ft)	Fuel (lbs)	Helicopter and Crew (lbs)	Total Weight (lbs)	Net Load (lbs)
0	1,963	18,000	19,963	5,037
2,000	1,765	18,000	19,765	5,235
4,000	1,679	18,000	19,679	5,321
6,000	1,610	18,000	19,610	5,390
8,000	1,545	18,000	19,545	5,455

For the given gross weight and range, a net load of approximately 5,300 pounds can be lifted by the CH-47A helicopter.

### III. Computations for Figure 11.

A. Determination of pressure altitude for a given pressure and gross load.<sup>11</sup> Wind velocity is assumed to be zero.

<sup>11</sup>U. S., Department of the Army, Operators' and Crew Members' Maintenance Manual Army Model UH-1D Helicopter (Bell), Technical Manual 55-1520-210-10 (Washington, D. C.: Department of the Army, 1963), Chapter 14, p. 2-15.

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Temperature °F	Pressure Altitude (ft)			
		(Gross weight lbs)		
		7,400	8,000	8,500
95	2,000			
59	5,300	3,300	1,900	
23	8,500	7,000	5,800	
-13	12,000	10,000	8,500	

B. Determination of net load for a given range and gross weight.<sup>12</sup>

1. Gross weight - 7,400 pounds; range - 92.5 kilometers radius.

Altitude (ft)	Fuel (lbs)	Helicopter and Crew <sup>13</sup> (lbs)	Total Weight (lbs)	Net Load (lbs)
0	739	4,856	5,595	1,805
2,000	725	4,856	5,581	1,819
4,000	737	4,856	5,593	1,807
6,000	773	4,856	5,629	1,771
8,000	830	4,856	5,686	1,714

For the given gross weight and range, a net load of approximately 1,750 can be lifted by the UH-1D helicopter.

2. Gross weight - 8,000 pounds; range 92.5 kilometers radius.

Altitude (ft)	Fuel (lbs)	Helicopter and Crew (lbs)	Total Weight (lbs)	Net Load (lbs)
0	763	4,856	5,619	2,381
2,000	772	4,856	5,628	2,372
4,000	819	4,856	5,675	2,325
6,000	905	4,856	5,761	2,239
8,000	1,097	4,856	5,953	2,047

<sup>12</sup>Ibid., Chapter 14, pp. 2-18 through 2-21.

<sup>13</sup>One crew member.

For the given gross weight and range, a net load of approximately 2,200 pounds can be lifted by the UH-1D helicopter.

3. Gross weight - 8,500 pounds; range - 92.5 kilometers radius.

Altitude (ft)	Fuel (lbs)	Helicopter and Crew (lbs)	Total Weight (lbs)	Net Load (lbs)
0	844	4,856	5,700	2,800
2,000	880	4,856	5,736	2,764
4,000	977	4,856	5,833	2,667
6,000	1,155	4,856	6,011	2,489
8,000	1,313	4,856	6,169	2,331

For the given gross weight and range, a net load of approximately 2,500 pounds can be lifted by the UH-1D helicopter.

4. Gross weight - 7,400 pounds; range - 55 kilometers radius.

Altitude (ft)	Fuel (lbs)	Helicopter and Crew (lbs)	Total Weight (lbs)	Net Load (lbs)
0	531	4,856	5,387	2,013
2,000	530	4,856	5,386	2,014
4,000	545	4,856	5,401	1,999
6,000	568	4,856	5,424	1,976
8,000	608	4,856	5,464	1,936

For the given gross weight and range, a net load of approximately 1,950 pounds can be lifted by the UH-1D helicopter.

5. Gross weight - 8,000 pounds; range - 55 kilometers radius.

Altitude (ft)	Fuel (lbs)	Helicopter and Crew (lbs)	Total Weight (lbs)	Net Load (lbs)
0	547	4,856	5,403	2,597
2,000	558	4,856	5,414	2,586
4,000	590	4,856	5,446	2,554
6,000	652	4,856	5,508	2,492
8,000	781	4,856	5,637	2,463

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For the given gross weight and range, a net load of approximately 2,500 pounds can be lifted by the UH-1D helicopter.

6. Gross weight - 8,500 pounds; range - 55 kilometers radius.

Altitude (ft)	Fuel (lbs)	Helicopter and Crew (lbs)	Total Weight (lbs)	Net Load (lbs)
0	610	4,856	5,466	3,034
2,000	639	4,856	5,495	3,005
4,000	768	4,856	5,624	2,876
6,000	831	4,856	5,687	2,813
8,000	954	4,856	5,810	2,690

For the given gross weight and range, a net load of approximately 2,800 pounds can be lifted by the UH-1D helicopter.

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### APPENDIX III

#### OTHER FACTORS IN WEAPON SELECTION

##### General

In selecting a weapon, there are certain factors which have a bearing even though they are not directly related to counter guerrilla warfare. These are cost, personnel requirements of the gun crews, survivability, and maintenance requirements of the weapon.

##### Weapon Cost

To make a true comparison of the cost of the various weapons, the cost of the prime mover in addition to that of the weapon are considered. Comparative costs are as follows:

1. M101A1 with prime mover - \$25,000
2. M102 with prime mover - \$40,000
3. M104 - \$33,000<sup>1</sup>

Though at first glance the cost of the M104 appears reasonable, one must consider the personnel requirements of the gun crew before the picture is complete. The M104 requires a seven man crew. The vehicle itself can carry only four men. Therefore, another vehicle is required to carry the remaining three crew members. In addition, ammunition and the section equipment must be transported in another vehicle, since only

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<sup>1</sup>U. S., Army Artillery and Missile School, Briefing: SP vs Towed and Accompanying Vehicles (Fort Sill: U. S. Army Artillery and Missile School, n. d.), n. p.

ten rounds can be stored on the vehicle. The cost of the accompanying vehicle which carries fifty rounds of ammunition, three personnel, and the section equipment, is estimated by the U. S. Army Artillery and Missile School to be \$13,000.<sup>2</sup>

Therefore, the cost of the M104 with an accompanying vehicle is actually \$46,000, making it the most expensive of the three weapons shown above. In other words, for the cost of equipping two battalions with the M104, two battalions plus a battery could be equipped with the M102.

#### Gun Crew Requirements

The 75-mm pack howitzer requires an eight man crew, the M101A1 and the M102 require nine each, while the M104 requires only seven. Therefore, there is a saving in personnel by using the M104 as the direct support weapon in counter guerrilla warfare.

#### Battlefield Survivability

Battlefield survivability is important in guerrilla warfare because of the maintenance and supply difficulties encountered in jungle and mountain operations. A tracked vehicle has a four-to-one advantage over the wheeled vehicle in the matter of battlefield survivability, which is based on the vulnerability of the suspension system or the ability of a vehicle to move after being damaged by enemy action.<sup>3</sup>

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<sup>2</sup>Ibid., p. 14.

<sup>3</sup>Ibid., p. 7.

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## Vehicle Maintenance

Another consideration is that of maintenance requirements. Figure 19 shows graphically the maintenance man-hours required versus vehicle weight for tracked and wheeled vehicles. The maintenance requirements for a tracked vehicle are approximately 50 per cent greater than for a wheeled vehicle. Also, according to the U. S. Army Artillery and Missile School, wheeled vehicles have a probability four times higher than that of tracked vehicles for remaining operational for 3,000 miles without a major breakdown. As pointed out, though, this has been true for the more complex tracked vehicles; and, since the M104 is powered by a standard one-quarter truck engine and uses a commercial transmission, its maintenance requirements should be reduced.<sup>4</sup>

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<sup>4</sup>Ibid., p. 6.

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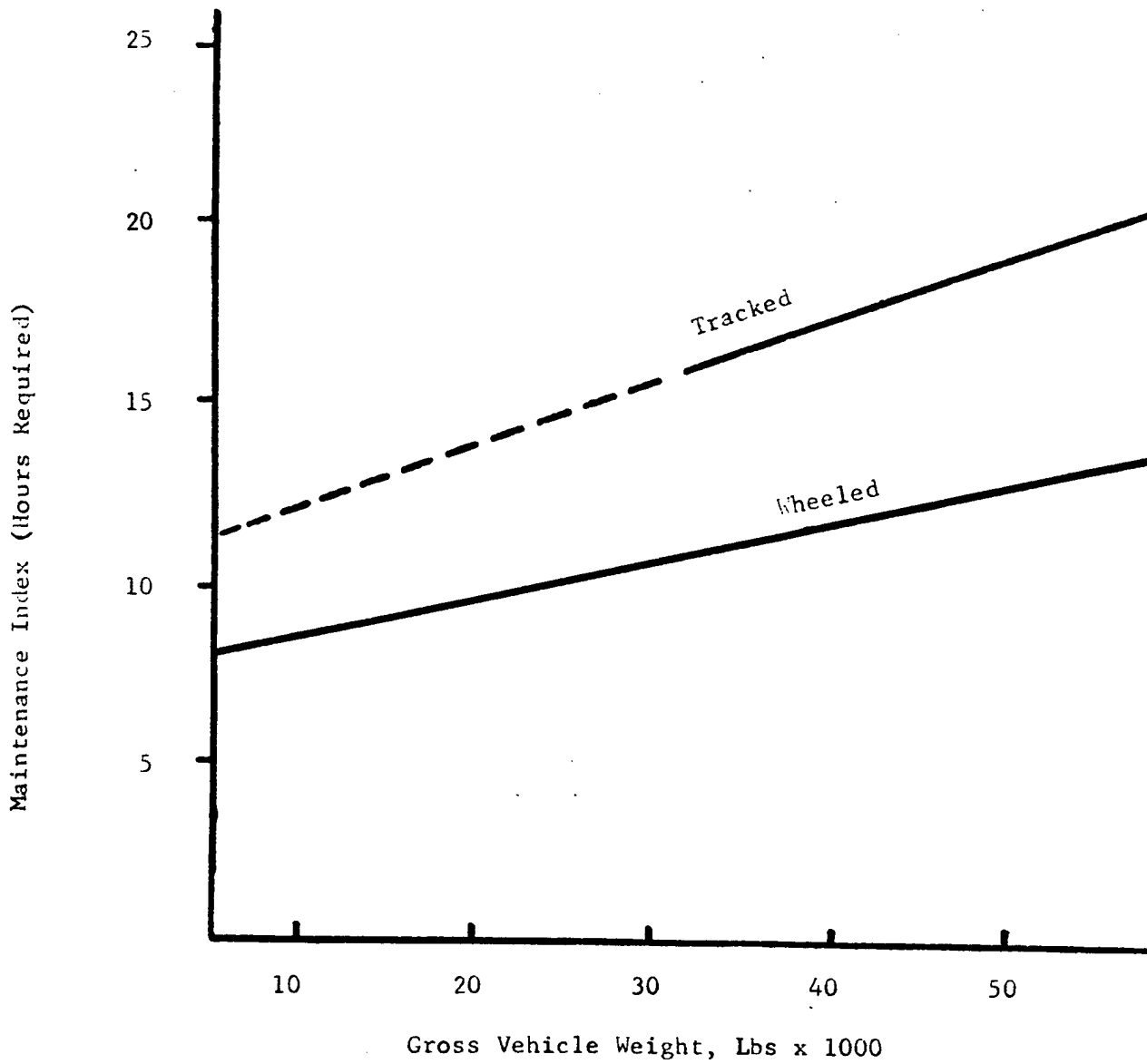


Fig. 19.--Maintenance requirements versus gross weight.<sup>5</sup>

<sup>5</sup>Ibid., n. p.

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